JUN 10 1924

CHEMICAL & METALLURGICAL ENGINEERING

McGraw-Hill Co., Inc. January 3, 1923 25 Cents Per Copy

FILTER-CEL

for speed and clarity's sake

It is only necessary to add Filter-Cel to the liquors you are now filtering to produce a filtrate of exceptional clarity.

Filter-Cel is chemically inert and extremely porous. It builds up a constantly renewing surface which retains the most minute particles of suspended matter. Filter-Cel improves keeping qualities and greatly augments the rate of flow.

OUR NEW BOOKLET

Shows how and where Filter-Cel is used in industries of process. Our engineers also have available a great deal of data pertaining to special commercial filtration problems.

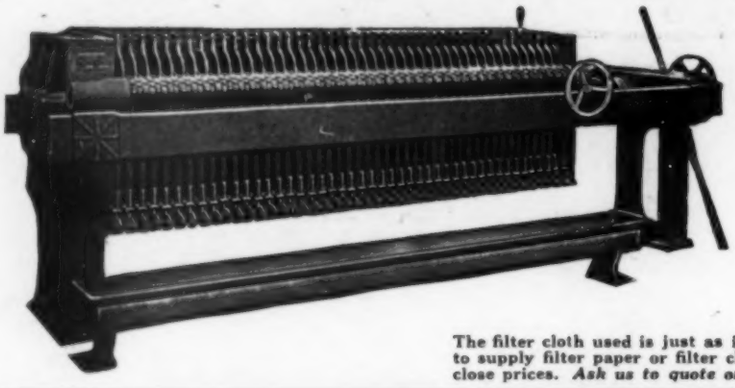
Send for Bulletin B.B.-40 and ask for data on your product— a post card will do.

CELITE PRODUCTS COMPANY

New York-11 Broadway Chicago-53 W. Jackson Blvd. San Francisco-Monadnock Bldg.

Offices and Warehouses in Principal Cities

CELITE PRODUCTS LIMITED, New Birks Bldg., Montreal, Canada



Shriver Efficiency

Many years of producing filter presses for all types of filtration work enable us to guarantee the results.

This guarantee of efficiency goes with every filter press we sell—we know our product, and we are ready to stand back of it. Write for catalog, stating your filtration problems.

T. SHRIVER & CO.
808 Hamilton Street, Harrison, N. J.

The filter cloth used is just as important as the filter press. We are in a position to supply filter paper or filter cloth especially woven for filter press work, at very close prices. *Ask us to quote on your filter cloth requirements.*

American Made Filter Paper

E. & A. Filter Paper is a crepe paper

Made from pure cotton rags.

Ideal for filtering a wide range of solutions, from weak caustic to strong nitric acid. Used in quantitative analysis, also in pharmaceutical, sugar and other industrial laboratories.

The best general all round filter paper.

A. D. L. Paper is for Quantitative Analysis

Distilled water only used. Double-acid washed. Subjected to a system of rigid inspection and testing which insures a high degree of uniformity. Sizes are from 5.5 to 18.5 cm. A. D. L. Paper retains Barium Sulfate and other fine precipitates without sacrificing the advantages of rapid filtration. It has exceptionally low ash content, is strong and easily folded.

Write for prices, stating your requirements

EIMER & AMEND

ESTABLISHED 1851

Headquarters for Laboratory Apparatus and Chemicals

WASHINGTON, D. C.
601 Evening Star Bldg.

NEW YORK CITY
200 E. 19th Street

PITTSBURGH OFFICE
4048 Jenkins Arcade

Chem. Engin.
Wilson
6-9-24
10293

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE
H. C. PARMELEE, Editor

Volume 28 · New York, January 3, 1923 · Number 1

Chemical & Metallurgical Engineering is the successor to *Metallurgical and Chemical Engineering*, which, in turn, was a consolidation of *Electrochemical and Metallurgical Industry* and *Iron and Steel Magazine* effected in July, 1906.

The magazine was originally founded as *Electrochemical Industry*, in September, 1902, and was published monthly under the editorial direction of Dr. E. F. ROEBER. It continued under that title until January, 1905, when it was changed to *Electrochemical and Metallurgical Industry*. In July, 1906, the consolidation was made with *Iron and Steel Magazine*, that had been founded 8 years previously by Dr. ALBERT SAUVEUR. In January, 1910, the title was changed to *Metallurgical and Chemical Engineering*, and semi-monthly publication was begun Sept. 1, 1915. On July 1, 1918, the title was changed to *Chemical and Metallurgical Engineering*, and weekly publication was begun Oct. 1, 1919.

Dr. E. F. ROEBER was editor of the paper from the time it was founded until his death on Oct. 17, 1917. After a brief interim he was succeeded by H. C. PARMELEE.

The staff of *Chemical and Metallurgical Engineering* comprises: H. C. PARMELEE, editor; ELLWOOD HENDRICK, consulting editor; ERNEST E. THUM, associate editor; J. S. NEGRU, managing editor; A. E. BUCHANAN, JR., CHARLES N. HULBURT, SIDNEY D. KIRKPATRICK, R. S. MCBRIDE (Washington, D. C.), GRAHAM L. MONTGOMERY, CHARLES WADSWORTH, 3RD, ALAN G. WIKOFF (Chicago), assistant editors.

The Hopeful Outlook

THE truth of the old adage that hope springs eternal in the human breast has been given fresh point and emphasis in the spirit of optimism with which the world has abandoned the old year and turned to the new. Nineteen-twenty-two has gone; and good riddance, say we all. The new year is at hand, fresh, promising, hopeful, and we welcome its opportunities as we do the next hole in golf after a particularly atrocious score. Another chance! A new opportunity! A clean sheet! Well, what shall be writ upon it? For 8 long years we have courageously faced a new beginning on January first, and December thirty-first has seen us dejected at failure and discouraged over the poor accomplishment. What reason is there now to believe that this year will yield us any better fruit and leave us with a greater degree of satisfaction?

First, there is increasing evidence that the United States is discovering Europe. Even irreconcilables who 3 years ago shouted their opposition to participation in the tangled affairs abroad and determined for us a policy of isolation that has all but wrecked international trade and finance now fervently declare that the economic distress of Europe is an American problem and that we must give aid in our own selfish interest. We name no names, being content to rejoice in an eleventh-hour conversion. Nothing, in our estimation, could so brighten the outlook for the whole world as a definite plan for the United States to participate actively in the study and solution of Europe's economic and financial problems. No partisan or personal motives should be allowed to hamper the President in his laudable plans; rather should he be strengthened in the knowledge that this country is now as ready to serve in restoring peace and prosperity as it was to enter the war in 1916. Time to create national sentiment was the essence of both situations; and it has been accomplished now as it was then.

Next, in the words of ELIHU ROOT, we are coming "to recognize not only our rights as citizens, but our duties," thus phrasing in a single sentence the quality of leadership that the world needs today. A quality, too, that is recognized far more clearly by engineers and business leaders than by those engaged in diplomacy and statecraft. Political parleys have failed miserably to bring men closer together, because they have been concerned more with rights than with duties. The problems of debts, disarmament and finance have been approached and regarded as though their amelioration was a matter of bookkeeping, of barter and trade, when as a matter of fact their real solution lies deeper in the moral and spiritual realms of international good will and desire for peace. Germany must cease her hating and France must cast out her fears.

Finally there has developed during the past year a respect for economic law that augurs well for the American business man. Much of his instruction may have been weak and immature, but economics has registered with him, and he is more disposed to base his actions on economic principles. In a few cases sound economics has even supplanted political expediency, thus giving an earnest of the heights that can be reached.

With Europe peaceful and under reconstruction; with a clear recognition of our duties as well as our rights as citizens; and with business at home on a sound economic basis, we can finish the year nineteen-twenty-three with a feeling of work well done. Let us hope it may be so! Man is essentially an optimistic animal. It would be inconceivable deliberately to look forward to failure.

A Stitch In Time

SOME WEEKS AGO we announced the appointment by the Assistant Secretary of War of a representative group of men in the chemical industry to co-operate with the War Department in its plans for preparedness against a national emergency. Back of this announcement is a well-organized and systematic campaign in the department to anticipate its varied needs for the national defence and at the same time to ascertain the industrial capacity of the country to meet those needs. The Surgeon-General's office recently announced a similar survey of industry. The thought behind this activity is a commendable desire to avoid the frantic haste and extravagance in the mobilization of industry that characterized the first year of our activity in the late war.

The Assistant Secretary of War is charged by law with the "supervision of procurement of all military supplies and all other business of the War Department pertaining thereto and the assurance of adequate provision for the mobilization of material and industrial organizations to war-time needs." Naturally this gives the Assistant Secretary a deep and abiding interest in the chemical industry, because, as he aptly stated in a recent issue of the U. S. Army *Recruiting News*, "Practically all modern warfare is chemical warfare." This, and much more to the same point, is a refreshing and practical appreciation of chemistry on the part of the War Department. Realizing its dependence upon peacetime industries for the national defence, the government understands that the more trained chemists there are in various branches of industry the more talent and ability will be available in emergency. No one will accuse the War Department of desiring to make war. Its present activities are highly businesslike as long as we maintain a War Department and charge it with the national defence.

Recovery in Steel Production

IN RETROSPECT it may seem easy for steel production to have increased by more than 75 per cent from 1921 to 1922, but it is not difficult to recall that a year ago it required some courage to predict any very great increase in production until "fundamental conditions" should be greatly improved. Judgment a year ago, moreover, was warped by the fact that with a moderate improvement in steel demand in the autumn there had come a sharp decrease in December. It now appears that the tapering off in demand at the end of 1921 was due to buyers being fearful of inventory, for before the end of January steel production had fully recovered its loss.

Production of steel ingots in 1922 was about 34,000,000 tons, which is a large or small tonnage according to the viewpoint. It was large by comparison with production in the calendar year 1921, being more than 75 per cent above the 19,224,084 tons produced in that year, and it was also large from the viewpoint of operations in December, 1921, which represented ingot production at a rate of less than 20,000,000 tons a year. On the other hand, the 34,000,000 tons of 1922 looks somewhat small by comparison with the record output, 43,619,200 tons, made in 1917, or the 40,881,392 tons made in 1920.

Comparison of steel production with "capacity" must be made with reserve and with qualifications. Prior to November, 1916, the steel industry was practically always able to operate at its "capacity" when it had the requisite orders. Since then it has never so operated, although capacity as properly estimated is based upon the actual output in 1916 plus a conservative allowance for new construction. There have been strikes, railroad congestion and other factors every time the mills were filled with orders. The capacity may be estimated at between 50,000,000 and 55,000,000 tons a year, and on this basis the 1922 production represents a working rate of only about 65 per cent.

The steel industry prospered much less in 1922 than would be expected from the bare fact that it was called upon to produce nearly twice as much steel as in the previous year, or from the circumstance of market prices having risen fully $10 a ton on an average. Finished steel prices reached their lowest point as to some commodities late in 1921 and as to other commodities at the end of February, 1922. Some of the prices were below cost of production. Prices rose but moderately until they were forced up sharply by rising costs, partly due to the coal strike and its curious outcome and partly due to the general wage advance in the steel industry itself, effective Sept. 1, and which was indeed caused partly by the coal settlement. Mill operations had been restricted and many producers had to make, at higher cost, steel that had been sold at close to the minimum prices.

The steel industry leaves behind it, with the old year, practically all of its low-priced business, and with moderately full order books hopes to reduce its production costs somewhat in the new year by efficient and steady operation. The steel market is in good condition and speculation concerns itself chiefly with the question of how long the condition will last.

Engineers, "Engineers" And Ethics

IT HAS often occurred to us to wonder, particularly during the past 2 years when so many engineers were unemployed, what sort of a feeling must come over the graduate mechanical, civil or chemical engineer when his hopeful eye encounters, midway in the "male help wanted" column, the insert, "Engineer," and then—"for new apartment house; steam heat and lighting plant; must make own repairs." And the same thought springs to mind at the sight of the alluring prospect on the back cover of the magazine: "Be an automotive engineer. We teach you to repair any make of car by our 6-week correspondence course."

That picturesque hero of MONTAGUE GLASS' "Partners Again"—*Abe Potash*—voiced the thought when he remarked to *Mawrus*: "I suppose when we were in the cloak and suit business, I was a clothing engineer!"

With all due respect to the man who can wind an armature, or set a Corliss valve, or time an internal combustion engine, we begrudge him the title of engineer—not because he is one whit less essential in the economic scheme of things; not because we were fortunate enough to win a degree that he lacks and not because he is any less intelligent or skillful or clever than the M.E. or C.E., but simply because his craft is distinct from ours and therefore, in justice to each of us, should have a distinctive name.

The general public is directly responsible for this promiscuous application of the term "engineer." It is a practice which will be corrected—not by telling the public what the "engineer" is not, but by showing it what the engineer is. In other words, the engineer must and will come into closer contact with his fellow

men in his professional capacity. He must apply his trained mind to the problems of immediate interest to the community—political, economic and sociological as well as technical. He must inspire a wholesome respect for his ability to think straight, plan accurately and produce results efficiently. He must drive home a realization that his professional efforts are directed toward one goal—the common welfare. He must "sell" himself to the public.

That, as we see it, is the main significance of the recent action of a joint committee of the foremost American engineering societies, in formulating a code of ethics for engineers, reproduced on page 34 of this issue. The code is a good one, in that it is specific, complete and sets a high standard. But the engineer does not need a printed rule book to tell him what is right and in keeping with the ideals of his profession. If he is any kind of an engineer, he knows that good ethics is good business. Nevertheless, the formulation of such a code, embodying in black and white the ideas that had lurked in some odd corner of his mind as intangible sentiments, will serve to crystallize those ideals and awaken him to a lively appreciation of their importance. The mere existence of a standard code of ethics will probably change the practices and policies of very few engineers. But when every engineer becomes imbued with the ideals and dignity of his profession as embodied in this code, when his reputation for fidelity, fairness, loyalty, integrity and public spiritedness becomes second nature, then will the new conception of the engineer be generally accepted and then may we well rest in peace under the entirely adequate inscription—"Here lies John Doe—Engineer."

Slow Versus Rapid Carburizing Heats

IT IS NOT our intention to show that case-hardened parts have distinctive qualities which excellently fit them for certain exacting duties. Such would be trite. It is more timely to call attention to some of the means that have been adopted to cut the cost of the carburizing operation, or to substitute special alloy steels which retain considerable toughness after hardening.

It is our opinion, however, that if all the factors were properly appraised heat-treaters would not so readily substitute "rapid" carbonizers, highly energized with chemicals and unstable organic compounds, for the older charcoal and carbonate mixtures which have done yeoman service for so many decades. About the only argument advanced for energized compounds is the specious one that they reduce the time the work is to be held at high temperature, and consequently save a large amount of fuel. An operation which requires 24 hours or longer is thus shortened to 8 hours or less, and a night fireman may be discharged.

But not even all of that is profit. It takes far more fuel to heat a cold furnace and a cold charge every morning than it does to heat the same charge in a furnace already hot. Once the furnace and contents are at carburizing temperature, it requires surprisingly little fuel to maintain them so, balancing the radiation losses, if the furnace is properly designed or one of a bank. Furthermore, alternate cooling and heating break up the furnace brickwork with surprising rapidity, and introduce a high charge for maintenance.

Taking all these factors into consideration, if there is sufficient carburizing to be done to load a furnace daily, it will be found that it costs little if any more to keep a good furnace at heat constantly than for 8 hours daily. Then why not use it for the entire twenty-four? In other words, why discard the slow carbonizer for the rapid?

Such a slow cycle allows the work to come to heat more gradually and brings the work to temperature without high differences of temperature, edge to center, in the individual pots. On the other hand pieces packed near the corners of a pot in a rapid carbonizer and placed in a rapidly driven furnace reach carbonizing temperature a long time before the work buried deeper. Consequently the depth and kind of case in the work packed in the same box often show wide variations, depending upon placement. For the same reason, and due to the fact that rapid heats often produce hot spots in a furnace, the production from short carburizing cycles is frequently far from uniform, pot to pot. All this is due to causes other than the inherent instability and variability in action of complex organic carburizers, in turn producing wide variation in expected results.

Thus it seems that the illusive saving in fuel when using short heats is very likely to be far overbalanced by losses due to non-uniform work. There is no excuse for using a piece having a deeply carburized case except that it is of superior quality. If this fact alone were held in mind, practices would never be tolerated that militate against the production of work having the utmost uniformity in properties. In our estimation the case for slower carbonizers is clinched without considering the facts that they are cheaper in first cost and never change the alloy or steel pots used for containers.

Recording Failure As Well as Success

NEGATIVE results of research pay no dividends. This is an axiom that seems to be all to well recognized among industrial executives. But these same executives should not forget that negative results from a research will often save expenses of large magnitude.

Negative results from a research that was reasonably promising at the outset should be recorded as a guide for future action. It is for this reason that we feel more than usual satisfaction in the presentation of a series of articles on low-temperature carbonization by Dr. HARRY A. CURTIS, who has been directing the research and development work on the Carbocoal process for several years past. This process has come nearer to commercial success than any other low-temperature work thus far done in the United States. Thus it is entitled to special consideration. Furthermore, the record which is now spread for the information of all has been made most satisfying in completeness, because it includes a statement of failures as well as of successes, and it tells why failure was met.

Low-temperature carbonization is by no means a cure-all for our fuel troubles. But low-temperature carbonization does promise to be one of the important fuel developments of the next few decades. No one has yet succeeded in making low-temperature carbonization sufficiently cheap to be a thorough commercial success. But this does not mean that future efforts will not succeed. Each effort, though only partly successful, should bring us closer to ultimate complete success. And if in the future as in the present case investigators will give others the benefit of the experience in work that was not satisfactory, the energies in later study will be bent toward more promising lines and investigators will have the guideposts of past experience to direct their course most accurately.

Readers' Views and Comments

Copper and Brass Research

To the Editor of Chemical & Metallurgical Engineering

SIR:—Several recent utterances in the technical press have read almost like strictures on the activities of the Copper and Brass Research Association. Doubtless, therefore, you will not be averse to presenting the other side of the case. In the words of Mr. Agassiz, president of the association, "The underlying purpose of this whole effort is to develop to the maximum the domestic consumption of the metal"—surely a praiseworthy object, as you will agree. Continuing, the official statement issued at the recent meeting of the board of directors, says:

> Our plan is to provide through the instrumentality of the Copper and Brass Research Association a technical and advisory service which may be freely called upon by users of our metals—a service which no one copper or brass producer or manufacturer could reasonably be expected to undertake alone. Already, wide use is being made of these facilities. Information has been furnished on the use of copper and brass for almost every conceivable subject, from safety pins to locomotive boiler tubes.
>
> An important accomplishment has been the fact that many of the more than 2,000 manufacturers who produce articles made of brass or copper have taken advantage of the association's activity to individually advertise their products, thus extending the association's own educational work.

Lastly, you would be rash to cast reflections upon the undoubted eminence of the recently elected executive committee: R. L. Agassiz, president Calumet & Hecla Mining Co.; Walter Douglas, president Phelps Dodge Corporation; C. F. Kelley, president Anaconda Copper Mining Co.; Stephen Birch, president Kennecott Copper Corporation; Charles Hayden, vice-president Chino, Utah, Nevada Ray companies; F. S. Chase, president Chase Rolling Mills; Edward H. Binns, president C. G. Hassey & Co.; H. J. Rowland, sales manager Rome Brass & Copper Co. MARTIN SEYT.

The Problem of Marketing Ideas

To the Editor of Chemical & Metallurgical Engineering

SIR:—In a recent interview with a talented chemical engineer he dropped an expression that had in it a touch of pathos: "I don't want cheese any more; I want to get out of the trap." Able, keen, nobody's fool in business either, he was finally cornered and hobbled in his work and in his living because the threefold nature of his task was too much for him. First, there was research and the development of his ideas through the laboratory stage. Second came the protection of his inventions by patent claims. In these fields he was thoroughly at home. Third, there was the sale of his patents or the granting of licenses under royalties and the exploitation of his inventions. Given a free hand with nothing else to do, he could manage this business also; not as a great negotiator, but acceptably, nevertheless. One difficulty lay in the fact that the ways of men are different from the ways of matter. Under precisely the same conditions and in the same physical state, matter will conform to its ways. You can trust matter if you know enough about it.

The study of man is a different field. What will a given man do under given conditions? Will he be straight or will he be crooked? Will he use good judgment, or will he let his thoughts go wool-gathering and proceed to guess wrong and invite failure? Here are problems in psychology that some men seem able to solve by prescience, although to outward appearances it would seem as if they were only guesswork.

Now the truly gifted man of research is full of ideas, contributions to humanity pressing for expression. If he addresses himself to negotiation with business men, the chances are that the ideas will die. He cannot invent and negotiate too. Men engaged in productive research are sacred possessions of their generation. They need aid and encouragement. They need friendly and sympathetic business relations. Negotiation with them is not a game like draw poker, although that is how the game is played in many instances. How shall the man of scientific talent and ability market his ideas without being beaten out of his rights? The answer to the problem will bring fame to the successful aspirant and peace and contentment to many inventors who know the ways of matter but not the ways of men.

New York City. E. H.

Artificial-Silk Progress in Germany

A recent canvass of artificial-silk manufacturers in Germany revealed the fact that few if any of these mills are today in a position to consider orders from abroad because of the large domestic demand. Many mills already have orders on hand sufficient to keep them busy for several months, and others have advised that they will not be in a position even to consider foreign business for some time, says *Commerce Reports* for Dec. 25, 1922.

One of Germany's best-known former ammunition manufacturers has evolved from guncotton a new product known as vistra, which was lately exhibited at the Munich Trade Exposition. It is understood that vistra may be mixed with silk, flax, cotton or wool, and a number of samples of imitation Smyrna rugs, silk sweaters and Gobelin tapestries employing it were shown at Munich.

Research on Edible Gelatine

The Edible Gelatin Manufacturers of America, Inc., announces the establishment of an industrial fellowship in the Mellon Institute of Industrial Research for the purpose of ascertaining the real food value of edible gelatine in its manifold applications in the American dietary.

In addition to experimental investigations, a correlation of all available facts regarding edible gelatine will be made, to be held at the disposal of all users and prospective users of the product. It is hoped that real service may be rendered by supplying scientific data and technical advice. The present incumbent of the industrial fellowship is Thomas B. Downey, who will be glad to furnish any available information to those interested in the uses of edible gelatine.

A Glimpse of the Liquid Carbon Dioxide Industry

Efficient Utilization of Energy and Materials in Coke Process for Production of Carbon Dioxide—Associated Manufacturing Departments Which Make It Possible to Render Complete Service to the Industry

BY ALAN G. WIKOFF

LIKE sulphur dioxide, carbon dioxide is one of the great inorganic intermediates, although this fact is not generally realized, since the bulk of the production reaches the market in a combined form. Thus the amount of carbon dioxide required for the manufacture of sodium carbonate and bicarbonate by the ammonia-soda process is probably not far from 500,000 tons per year. Gases from limekilns in which the coke fuel is mixed directly with the limestone form the source of supply. Limekiln gases are also used for the carbonation of sugar solutions during the refining process. In each of these industries the carbon dioxide is used on the spot and the lime produced simultaneously is also required in the process.

With the growth of the carbonated beverage industry it became necessary to perfect arrangements whereby carbon dioxide could be conveniently transported and distributed. The gas was liquefied by compressing into strong steel cylinders, and it is the development of this phase which is usually referred to as the carbon dioxide industry. Nearly 60,000,000 lb. of liquid CO_2, valued at more than $6,500,000, was produced in 1919.

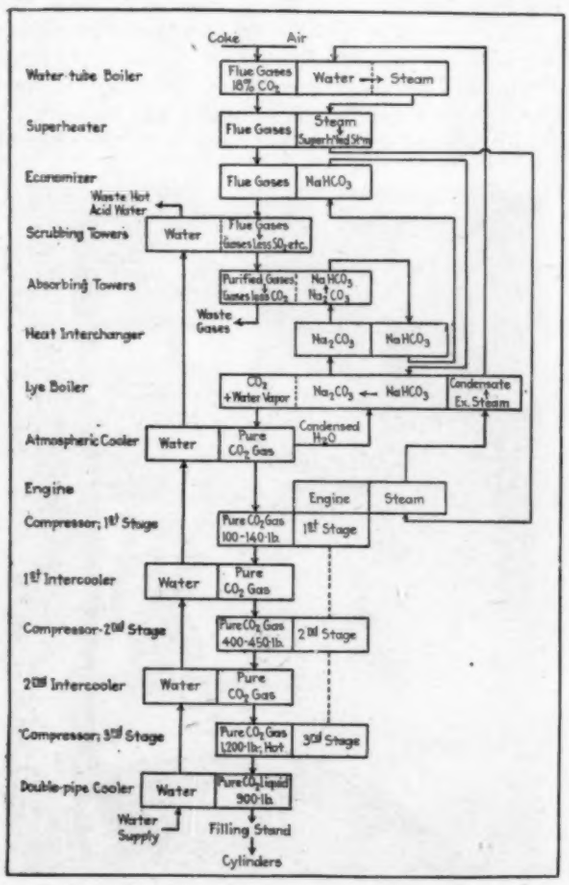


FIG. 1—FLOW SHEET

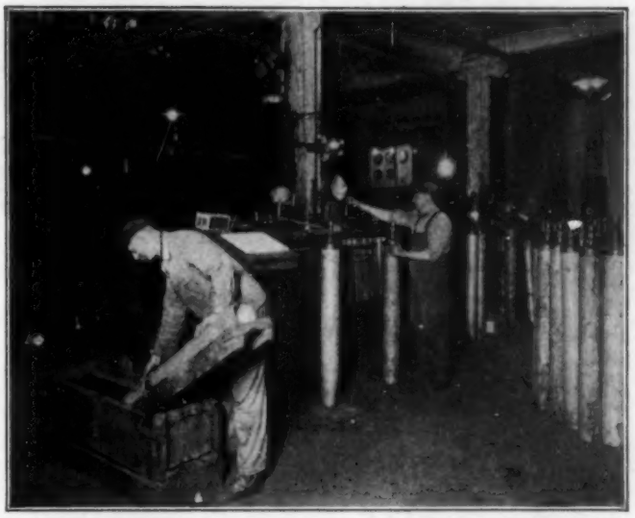


FIG. 2—FILLING CYLINDERS WITH CARBON DIOXIDE

Obviously, for beverage purposes purity is a primary consideration and it is also essential to exclude other gases. These points must be considered in selecting the method of production. Since power is required to compress the gas, the recovery of pure CO_2 from the flue gases of a coke-fired boiler has proved to be most economical. Recently some liquid CO_2 has been produced as a byproduct of industrial alcohol fermentation, but the greater part is made by the coke process. This is used by the Liquid Carbonic Co. in its thirteen plants, which have a total annual capacity of more than 30,000,000 lb. These are located at Chicago, Pittsburgh, St. Louis, Memphis, New York, Cincinnati, Kansas City, Minneapolis, Atlanta, Dallas, Boston, Philadelphia and Ashland. While of course the different installations vary somewhat in detail, the Chicago plant of this company may be taken as typical. The associated plants here are also of particular interest in showing the logical development of an organization for rendering complete service to an industry. Starting with the gas and carbonators, the company is now prepared to furnish every detail of the dispensers' and bottlers' requirements.

Briefly, the process of manufacture consists in burning coke under a boiler, absorbing the carbon dioxide in sodium carbonate solution and boiling the sodium bicarbonate solution to liberate pure CO_2, which is then compressed into cylinders. Steam furnished by the boiler supplies the energy required for compression and the heat in flue gases and exhaust steam is used to best advantage. As a result, the process forms an interesting example of efficient utilization of energy and materials. The various cycles and counter-current arrangements are indicated in the accompanying flow sheet, Fig. 1, and described in some detail in the following paragraphs.

Low sulphur content is a primary requirement for the

FIG. 3—MARBLE YARD

coke used. It should be low also in ash and the fusion point of the ash should be as high as possible. At present, coke containing less than 0.8 per cent sulphur is burned at Chicago. It may originate in either beehive or byproduct ovens.

This coke is burned under 200-hp. Kroeschell combination fire and water-tube boilers equipped with superheaters and economizers. Hand firing is employed, combustion being controlled through Ellison differential draft gages (connected right over the fire and also after the boiler) and a Uehling CO_2 recorder with an indicator on the boiler front. The flue gases regularly contain 18 to 19 per cent CO_2. Coke consumption is about 850 lb. per hour per boiler—approximately 1 lb. coke being required to produce 1 lb. of pure carbon dioxide. The boilers operate independently, as the plant consists of two complete units to obviate the possibility of a shut-down in case of accident to some part of a unit. As the two installations are exact duplicates, only one need be described.

After some of the heat has served to superheat the steam and to warm up bicarbonate solution in the economizer, impurities in the flue gases, particularly smoke, dust and sulphur dioxide, are removed by countercurrent scrubbing with water in two limestone-filled towers run in series. Because of the final temperature of the scrubbing water practically no carbon dioxide is lost. To insure complete removal of sulphur compounds it is essential that all the sulphur in the coke should have been burned to SO_2, with possibly traces of SO_3. Hydrogen sulphide is always avoided because of the tendency to pass right through the purification process and contaminate the product. The hot acid water discharged from the scrubbers is thrown away, as it is not possible to use it economically.

Absorption of carbon dioxide takes place in two coke-filled towers operated in series. Each tower is about 100 ft. high and contains about 110 tons of coke. A Roots blower draws the gases through the boiler and scrubbers and forces them through the two absorbers counter-current to the alkaline liquor, which enters the top of the first tower as sodium carbonate solution and leaves the bottom of the second absorber as sodium bicarbonate solution. Circulation is maintained by Goulds centrifugal pumps. Complete removal of the carbon dioxide is not feasible and the waste gases still contain about 10 per cent CO_2. This represents the economical limit, although in some cases the addition of a third tower may increase the recovery more than enough to offset the extra investment charges.

From the bicarbonate solution, carbon dioxide is recovered by simply boiling. The solution is preheated by passing through a heat interchanger, then through the economizer previously noted in connection with the coke-fired boiler. It then passes to the lye boiler, which is heated by exhaust steam. Here the carbon dioxide is boiled off under 8 to 9 lb. pressure, while the regenerated carbonate solution returns to the absorbers, passing first through the heat interchanger, where it serves to preheat the bicarbonate liquor about to enter the lye boiler.

Great care is taken to see that pipes leading from the absorbers to the boilers are at all times completely filled with liquor so that no air may enter the system. Furthermore, a pressure of 4 to 5 lb. is maintained on the CO_2 until it reaches the compressors so that it will not be possible for air to enter even should there be slight leaks in the piping. As the CO_2 is liberated from a boiling aqueous solution it is, of course, saturated with water vapor, but this is condensed in an atmospheric cooler, leaving the pure CO_2 ready for compression. The condensate is returned to the alkaline liquor cycle.

Still under slight pressure, the gas passes to a three-stage Worthington compressor driven by a 125-hp. Erie City Iron Works Lentz engine. The first stage is double acting and raises the pressure to 100-140 lb. After passing through an intercooler, this is increased to 400-450 lb. in the second stage, followed by another intercooler and the third stage, which delivers the gas under 1,100-1,200 lb. A double pipe cooler reduces the temperature below the critical temperature (31.35 deg. C.) and the carbon dioxide liquefies. It is distributed in the familiar 20-lb. or 50-lb. steel cylinders. These are placed on scales at the filling stand, the tare adjusted and the proper amount of liquid CO_2 run in. The cylinders are then inverted so that the valves dip in a trough of water, which indicates any leakage. The cap is put on and another test made with the stem open

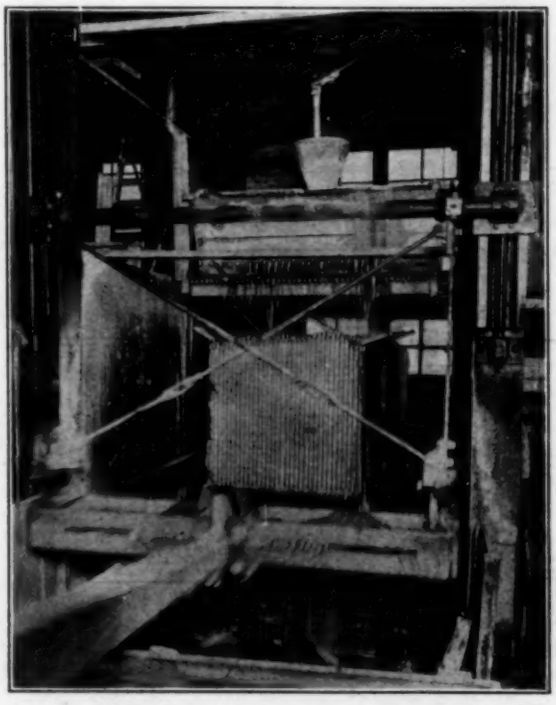


FIG. 4—GANG SAW CUTTING MARBLE SLABS

FIG. 5—RUBBING BED

to make sure that the cap is tight. The pressure in the cylinders is about 900 lb. at 70 deg. F. The operations of filling the cylinders and testing the valves for leakage are shown in Fig. 2.

At this point let us return for a moment to a consideration of the interrelation of the different steps in the process as indicated by the flow sheet. Coke and the air required for its combustion enter the system at the boiler and the products of combustion are separated into waste gases and pure carbon dioxide. Water from a deep well flows through the pure CO_2 coolers in a counter-current direction and is then fed to the scrubbing towers, emerging as waste hot acid water. Two closed cycles complete the process. The alkaline liquors circulate continuously through absorbing towers, heat interchangers, economizer and lye boiler. Superheated steam from the water-tube boiler operates the engine, the exhaust serves to boil the bicarbonate solution, while the condensate is returned to the boiler. Actual operation of the plant requires the services of only three men —engineer, fireman and a man at the filling stand. Men engaged in testing and handling cylinders raise the number of employees to five or six. An experienced chemical engineer is in charge of the plants.

Cylinders are purchased and as they have been tested under the supervision of the Bureau of Explosives by the manufacturer before sale it is not necessary to test them for 5 years. As the empty cylinders are received for refilling, the dates stamped on them are examined and those which require testing are set aside. Others about which there is the slightest doubt are added to the group. In testing, a cylinder is filled with water and the pressure raised to 3,000 lb. per sq.in. by means of a hand-operated hydraulic pump. The cylinder is permitted to remain under pressure for 2 minutes, during which time any expansion is indicated by a drop in pressure. Should the pressure drop exceed a small permissible value, the cylinder is rejected. A Columbia recording gage gives a permanent record of all tests.

As an additional safeguard the valve is provided with a safety vent closed with a metal disk which will rupture should the pressure exceed 2,700 lb. In this way the bursting hazard becomes negligible, since the normal pressure in the cylinder is only about 900 lb. The valves are of the packing type and are made by the company.

Owing to the universal demand for carbonated beverages, it has been necessary to develop a distribution system which embraces practically every community, by means of distributing depots and jobbers, where large stocks of full cylinders are kept. This ready availability is an important factor with the chemist or the engineer who is considering the use of carbon dioxide for its inertness or its chemical properties. It is the cheapest inert gas available.

FIG. 7—GENERAL VIEW OF TIN SHOP

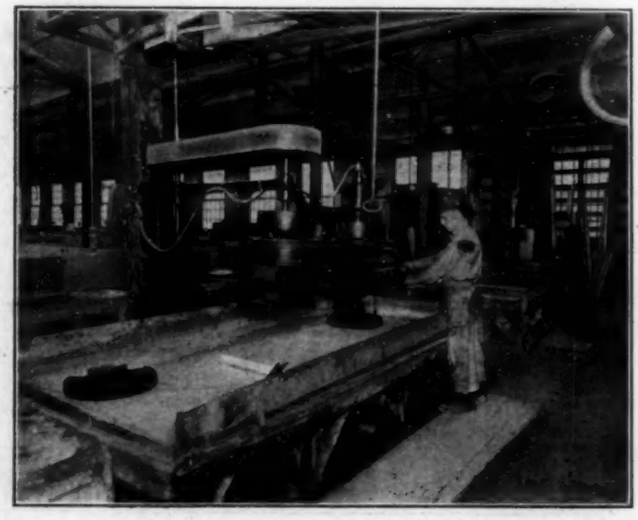


FIG. 6—POLISHING MACHINES

While the greater part of the output is used for carbonation purposes, several other applications have been developed. For refrigeration, particularly household units, it possesses certain advantages over ammonia and sulphur dioxide. The manufacture of salicylic acid is typical of its use in the production of chemical products. Other applications include: Fire protection, food preservation, water purification, local anæthesia. New uses are constantly being developed through a fellowship which has been established for the purpose by the carbon dioxide manufacturers at the Mellon Institute for Industrial Research.

While the carbonated beverage industry could not exist without a convenient gas supply, it is equally true that without additional equipment a cylinder of carbon dioxide would be of no value to the dispenser. Means must be provided for preparing charged water and delivering it to the fountain. It is only natural that the

manufacture of machines for this purpose should supplement the production of carbon dioxide. Following this idea to its logical conclusion, it is not surprising to find that the greater part of the Chicago plant of the Liquid Carbonic Co. is devoted to the manufacture of products other than CO_2. A brief outline may serve to indicate the diversified character of these operations.

Having supplied the dispenser with gas and carbonator, it is but a step to the complete fountain with all accessories. Production of the fountains requires a marble shop, wood-working or cabinet shop, and sheet-metal department, together with facilities for assembling the various parts.

Marble from foreign and domestic quarries is received in the form of the huge blocks shown in Fig. 3. These are cut into slabs by gang saws, Fig. 4, the blades of which have no teeth. Cutting action is due to sharp sand carried by streams of water from an overhead trough. Continuous operation for about 2 weeks is required to cut through an 8-ft. block. After cutting to size, the slabs are polished. This operation starts on the large horizontally rotated cast-iron wheels or rub-

FIG. 8—FOUNDRY

bing beds shown in Fig. 5, where fine sand forms the abrasive. High polish is obtained by the use of carborundum and other finer materials on machines of the type illustrated in Fig. 6. After finishing to size, the pieces are fitted together to make sure that there will be no difficulty in erecting. Meanwhile the rest of the fountain—the wooden or steel framework, the cork insulation, the pressed sheet-metal parts, the fixtures and fittings—has been assembled in the tin shop, Fig. 7. Certain sizes and arrangements have been adopted as standard, although much special work must be done to meet the whims of certain customers.

Mention has already been made of the carbonators used by dispensers. A larger model is required by establishments which make bottled carbonated beverages. This is an important and growing branch of the industry, and a complete line of equipment has been developed to meet the needs of the bottler. In addition to the carbonator, there are the siruper, the filler, the crowner and the washer. The operation of the carbonator, siruper and filler has been discussed in an article on the ginger ale plant of the Beech-Nut Packing Co.[1]

[1] "Automatic Equipment and Chemical Control," G. L. Montgomery, *Chem. & Met.*, vol. 27, p. 160, July 26, 1922.

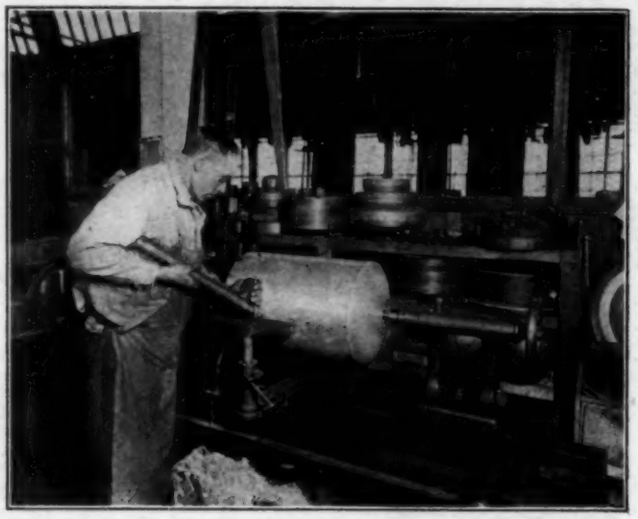


FIG. 9—SPINNING BLOCK TIN CARBONATOR LINING

A good-sized plant is required to turn out this equipment, together with such miscellaneous parts as cylinder valves and pressure regulators. There is a large foundry designed for crucible melting of non-ferrous metals and alloys, Fig. 8. The non-ferrous castings, and also the variety of iron and steel parts, are worked up in a well-equipped machine shop connected with the plant, and finally assembled.

Solutions of carbon dioxide being weakly acid, it is necessary to exercise caution in choosing the materials with which they may come in contact, which explains the extensive use of non-ferrous metals. Only tin and silver are used in contact with carbonated water and sirups containing fruit acid. The carbonators are lined with block tin and one of the interesting operations in the machine shop is the spinning of this lining, Fig. 9. Many of the fixtures on the fountains—for example, the sirup pumps—are silver plated, so that the plant includes a silver-plating department which is one of the largest in the Chicago district for industrial purposes.

Fig. 10 shows the final assembly of the carbonators. These machines are very compact and are entirely automatic in operation. Carbon dioxide from a cylinder connected through a reducing valve is passed into water agitated in the mixing chamber, water pump and agitator being driven by an electric motor. Automatic

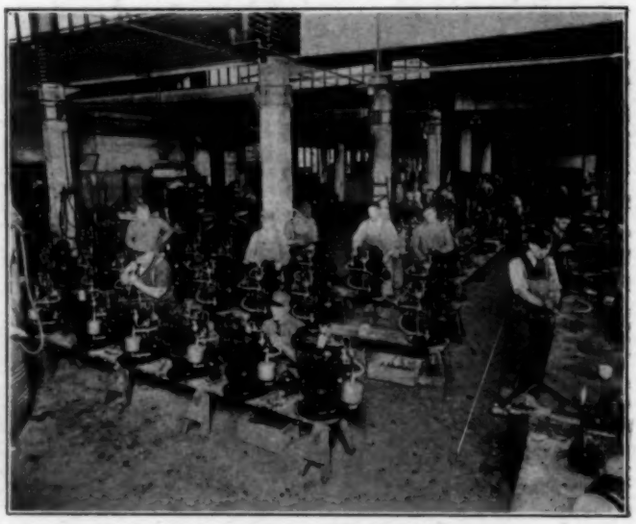


FIG. 10—ASSEMBLING CARBONATORS

control of motor and gas supply is obtained through the counterbalanced external chamber which operates a rocking mercury switch. Although in direct communication with the mixing chamber, so that free flow of liquid is possible, the external chamber can move up and down within certain limits and the counterweight is so adjusted that fluctuations in the liquid level will operate the switch.

Another large department prepares crushed and preserved fruits, soda fountain flavors and bottlers' extracts. Fresh fruits, such as strawberries, cherries, peaches and pineapple, are cooked in closed glass-lined kettles, canned and placed in storage for shipment. Soda fountain flavors as a rule contain the necessary amount of sugar sirup, while bottlers prefer to add their own sirup and save transportation charges. Recent progress in this direction has led to the development of highly concentrated emulsions, which contain practically nothing but the flavoring materials.

This department has a large laboratory for control work, research and service to customers, under the direction of an experienced chemist. Such tests as the gas plants may require are also conducted here.

A small fountain is installed so that all flavors may be tested by tasting. There is also complete equipment for conducting a bottling test, as well as several ice cream machines for work on this product. Refrigeration is supplied by a Kroeschell CO_2 machine.

While it has not been possible to go into detail, it is hoped that this review may serve to show how a large manufacturing industry has been built up around the production and distribution of a single chemical product.

The writer is greatly indebted to the management for courtesies extended and in particular to Edwin D. Hale, Chemical Engineer, for assistance in the collection of data.

Value of Commercial Training in Technical Schools

That engineering college graduates are handicapped without a supplementary commercial training is the basis of research investigations just completed by Dr. W. F. Rittman and W. F. Reilly, of Carnegie Institute of Technology, Pittsburgh.

A study of the present occupations of Carnegie Tech graduates was made. Of the graduates from 1908 to 1921, the investigations showed that approximately 67 per cent of the total engineering graduates are now engaged in commercial or managerial work. This majority becomes significant in consideration of the fact that "engineering" graduates include a wide range of highly technical fields such as mechanical, electrical, civil, chemical, metallurgical, mining, sanitary, and science.

An interesting tabulation in the report shows the following percentages of engineering graduates in all departments who are now in commercial or managerial capacities: mechanical engineering, 65 per cent; electrical engineering, 60 per cent; civil engineering, 73 per cent; chemical engineering, 59 per cent; commercial engineering, 91 per cent; metallurgical and mining engineering, 67 per cent; sanitary engineering, 60 per cent; science, 77 per cent.

One of the two most important generalizations cited by the authors in their report is that "the great majority of graduates use their technical education as a means of getting into commercial or managerial work. It is believed that a similar study of the activities of the graduates of other technical institutions would show this same order of classification."

Glass Rings—A New Filling Material for Towers

By F. C. Zeisberg
Chemical Engineer, the du Pont Company

In a recent article[1] entitled "The Efficiency and Capacity of Fractionating Columns," W. A. Peters, Jr., describes experiments on fractionating columns packed with various materials; among others, hollow cylinders. It was shown that hollow cylinders have so much greater capacity per square foot of gross cross-sectional area than solid filling material of approximately the same dimensions that it seemed worth while pursuing the matter to see whether such hollow cylinders in small sizes could not be produced commercially. The desirability of the smaller sizes lies in the fact that the separating efficiency in a packed fractionating column increases almost directly as the size decreases.

So-called Raschig rings of earthenware and metal have been used for some time, but of larger dimensions than Mr. Peters' experiments indicated to be desirable. Thus, the General Ceramics Co. makes unglazed earthenware rings, 1x1 in. with ⅛-in. walls, of two different types. One of these is a plain, open-ended, hollow cylinder, the other a similar cylinder with four notches at each end. Maurice A. Knight makes both glazed and unglazed cylinders in four sizes: ⅜ in. with ⅛-in. walls, ½ in. with 1/16-in. walls, 1 in. with 1/16-in. walls and 1¼ in. with ¼-in. walls.

In Germany both porcelain and metal rings have been in use for some time, but so far as we have been able to learn the smallest size used up until now is 15x15 mm., with 2-mm. walls in the case of porcelain and 0.5-mm. walls in the case of metal.

In England, Lessing[2] has attempted to improve the metal ring by adding a single central partition. This increases the surface of a given ring about 32 per cent. The Hydronyl Syndicate of London is marketing Lessing's ring in several sizes and in a variety of metals, such as copper, iron, aluminum and nickel. The cost of these rings is rather high.

It is probably true that the commercial limit has been reached with respect to further decrease in size of earthenware rings. Not only does the effective free space rapidly decrease as the ring size decreases, owing to the necessity of keeping the walls comparatively thick, but the cost of handling the rings in the drying and burning operations rapidly increases also. Furthermore, for some purposes, as, for example, handling hot sulphuric or nitric acids, the earthenware rings are not entirely suitable, tending to disintegrate.

While metal rings can easily be made of any desired size, no matter how small, by the use of automatic machinery, here the increase in surface per cubic foot of rings as the size decreases can in some instances work harmfully rather than otherwise. For example, in the distillation of acetic acid through a copper column filled with copper rings, the action of the acid on the copper is comparatively slight, measured in inches penetration per month, but when the enormous area exposed by the smaller size rings (252 sq.ft. per cu.ft. for ¼-in. Lessing rings) is taken into consideration, the total amount of copper dissolved is no insignificant factor.

---

*Paper presented before American Institute of Chemical Engineers, Richmond, Va., Dec. 6-9, 1922.

[1] *J. Ind. Eng. Chem.*, vol. 14, pp. 476-9 (1922).

[2] *J. Soc. Chem. Ind.*, vol. 40, pp. 115-19T (1921).

TABLE I—PROPERTIES OF GLASS FILLING RINGS

Chemical Department, E. I. du Pont de Nemours & Co.

Size*	4	5	6	7	8	9	10	11	12
No. per cu.ft.	369,000	189,000	109,300	68,800	46,100	32,400	23,600	17,750	13,650
Wt. per cu.ft., lb.	52.0	49.1	46.2	43.4	40.5	37.7	34.8	32.0	29.1
Sq.ft. per cu.ft.	415	332	274	233	203	178	160	144	130
Per cent free space	66	68	69	71	73	75	77	79	81
Wall thickness, mm.	0.58	0.63	0.68	0.73	0.78	0.83	0.87	0.92	0.97
Resistance, inches H_2O	9.4	6.7	5.0	3.8	3.0	2.4	1.9	1.55	1.27
Price per cu.ft.	$115.00	$65.00	$42.00	$31.00	$24.00	$20.00	$17.00	$15.00	$13.00

* The size number of the rings is simply the outside diameter in millimeters.

This holds, of course, wherever the metal composing the ring is attacked, however slightly, by the vapors or liquids coming in contact with it, and this condition obtains in a surprisingly large number of works-scale cases.

It seemed to us, therefore, that neither metal nor earthenware promised to be the ideal material of which to fabricate small rings. In looking about for such a material, glass naturally suggested itself. Glass is a fairly cheap material, is inert to a large variety of chemicals, possesses the necessary strength, is a poor conductor of heat (which is an important consideration in a column where reactions occur having a marked temperature gradient) and is readily cleaned.

Considerable effort has been spent on methods of manufacturing these glass rings, and this has been successful to the point that the chemical department of the du Pont company is now in a position to market small glass rings at prices which make them attractive for a number of operations, notably for the filling of small distilling columns. The rings can be made in a large range of sizes. For each operation, however, there is an optimum size, indications being that for all-around purposes ring No. 11 is about the best. Table I shows the properties of the various size rings.

It should be emphasized that the weight, wall thickness, free space and surface shown in the table are only approximate. The wall thickness for a given size can be varied considerably, and with it all the other properties vary as a matter of course. The properties given, however, are for what appears the best proportioned ring.

The resistance shown is the pressure necessary to force 1,000 lb. air per hour, at 20 deg. C. and 760 mm., through a bed of rings having a cross-sectional area of 1 sq.ft. and a depth of 1 ft. The figures were calculated by the formula given in F. C. Blake's paper, "Resistance of Packing to Fluid Flow," and are probably accurate to within less than 10 per cent.

The prices given are tentative. They are for quantities of 50 cu.ft. or more and are f.o.b. Wilmington, Del. Prices on small quantities of the smaller rings for laboratory use will of course be considerably higher.

The du Pont company has these rings in use in several distilling operations. For example a 9-in. column, filled with 13 ft. of No. 9 rings, is producing 2,000 lb. per day of 90 per cent (by weight) alcohol from a 60 per cent feed alcohol, with a heat flow up the column of 220,000 B.t.u. per sq.ft. of cross-sectional area per hour. The performance is equivalent to that of a thirty-five-plate column, and has been satisfactory from the first.

In a second operation a 4-in. column, packed with 11 ft. of No. 11 rings, is used in stripping a 28 per cent ammonia liquor. The feed rate is 90 lb. of liquor per hour, with a heat flow of 395,000 B.t.u. per sq.ft. of cross-sectional area per hour. A vapor at approximately room temperature is delivered from the top of the column, while the hot water running from the base is NH_3-free. In this case only 6 ft. of the packed space is really functioning, equivalent to about sixteen plates, the remaining 5 ft. being used as insurance.

To illustrate the readiness with which these glass rings can be cleaned, this NH_3 column stopped up several weeks after being put in operation, and when it was opened the rings were found stuck together with a dark brown deposit which was found to be iron salt. The rings were simply removed, treated with commercial hydrochloric acid, which readily dissolved the deposit, washed with water and replaced in the column.

In conclusion, it should be stated that the du Pont company has made what is felt to be only a very limited application of these rings to works-scale operations. Those applications susceptible to patent protection, however, as well as the phases of ring manufacture which can be covered, have been taken care of.

Sagger Problems Being Investigated

Saggers are containers employed in manufactories of chinaware for holding plates, cups, saucers, etc., during the firing in the kiln. These containers are made of clay which must have considerable strength and be of good refractory quality. The Bureau of Standards is conducting a thorough investigation involving a geographical study of sagger clays to classify them according to their properties, and finally to see what may be done toward increasing the life of the sagger.

To obtain a list of the sagger clays used throughout the country, letters were sent to 100 different manufacturers using these clays. About ninety different clays, or rather clays sold under approximately ninety different names, are used for saggers in the United States.

Samples of fifty-two different clays, representing as well as could be judged all the important types, are being obtained in 200 lb. lots from the users rather than from producers or dealers. Manufacturers are contributing these rather large samples from their stocks and prepaying the freight to Washington.

In order to classify the sagger clays according to their properties, they are being subjected to the following tests: Water of plasticity, shrinkage, porosity, transverse strength, and burning behavior at five different cones. It is considered necessary, in order that the results of these tests may be of value, to devise, where necessary, methods or modifications of methods which will insure greater accuracy than is usually attained in such measurements. This involves the elimination of sources of variation all along the line in order to obtain close checks in the final results. As this is a feature which justifies closer attention than it has received up to this time from ceramic industries, it is proposed to include in the report of this investigation not only averages but maximum departures from these mean values.

The Low-Temperature Carbonization of Coal

I—The Development of the Carbocoal Process at the Irvington Plant of the International Coal Products Corporation

By Harry A. Curtis and Walter J. Chapman

THE present paper is the first in a series of articles which will be published by the senior author and several of his co-workers dealing with the project of manufacturing a smokeless fuel through processes involving the low-temperature distillation of coal. In describing the development of the Carbocoal process in the present paper there will necessarily be included considerable data of general application in any low-temperature carbonization process, for many of the problems encountered in the development of this particular process are not specific to the process, but are inherent in the nature of the operations to be carried out, regardless of the methods used.

There have been about sixty different retorts invented for carbonizing coal at relatively low temperatures. Many of these retorts are worthless because they disregard some of the fundamental principles of the art. It has cost time and money to discover these principles, and it is well that they are recorded. Nor is the problem of producing smokeless fuel solved when a successful retort has been developed. The question of what to do with the carbon residue turned out by such a retort must be answered also, for this carbon residue is not in suitable shape for the market.

Looking back over the records of the large-scale experimental work carried on at the Irvington, N. J., plant, it is easy to see that the company rushed into the use of large-scale apparatus and consequent heavy expenditures before small-scale experiments had disclosed the essentials of the Carbocoal process. It is true that inevitably there would have come a time in the development of the process when only large-scale apparatus would give the final data for plant construction, but the large-scale work at Irvington was premature. All of the early work at Irvington suffered from lack of good engineering, and many of the experiments were performed unnecessarily. In spite of these facts, however, progress was slowly made toward a successful process and a great deal of experience in the art was accumulated.

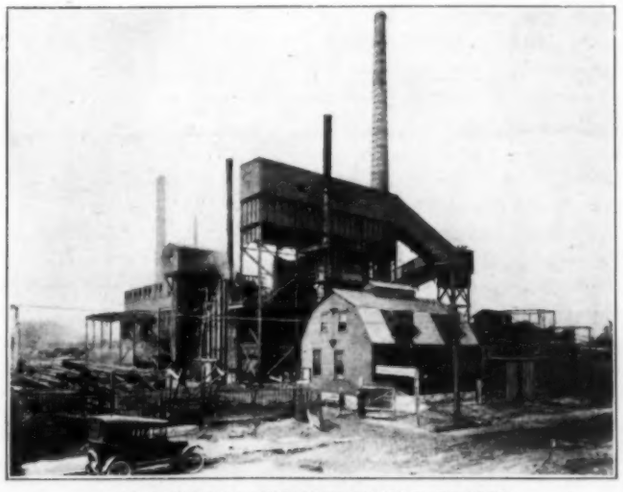
Experimental work was begun at the Irvington plant in May, 1915, and discontinued in June, 1921, after the Clinchfield, Va., plant had been in operation for a year. During this period several types of full-size low-temperature retorts were built and tested; methods of handling the carbon residue were devised; the art of briquetting the carbon residue was developed; and methods of carbonizing the briquets to make them smokeless were worked out. In the following pages a very brief summary of this work is presented.

Retorts No. 1 and No. 2

The original scheme of the Carbocoal process was to remove only such a part of the volatile of the coal as would leave the residue plastic and then to briquet the plastic.[1] This idea was later abandoned, for reasons which will appear, but Retorts No. 1 and No. 2 were built with this original scheme in view.

Retort No. 1 was fabricated by H. W. Caldwell & Sons and set up at Irvington during the summer of 1915. It consisted essentially of a horizontal, stationary, cast-iron cylinder, 36 in. in diameter and 17 ft. long, made in two sections, with a single paddle shaft through the center. The paddle shaft was an 8-in. wrought-iron pipe, with gudgeons for bearings in each end, and carried about forty paddles bolted in the shaft, the paddles being set at an angle so as both to stir the coal and to advance it through the retort. Crushed coal was fed from a bunker through a 6-in. helicoid screw, and dropped down a 7-in. pipe into the retort. The plastic carbon residue was discharged through a single 6-in. helicoid screw turning in a 7-in. pipe casing. The paddle shaft, feed and discharge were driven from a single motor through a worm gear. A simplified sketch of this retort is shown in Fig. 1.

When Retort No. 1 is regarded in the light of 7 years' accumulative experience which the company has now had in this line, it is amusing that such a retort should have been built and that most persistent efforts should have been made to operate it. And yet patents are being granted right along on retorts as impossible as this one. Tests were started with Retort No. 1 in September, 1915, and continued for more than a year in spite of the fact that practically every test ended in disaster within a few hours after it was begun. The final stage in every test which was not earlier terminated by plugged feed, plugged discharge or broken machinery was a retort plugged with carbon residue. The plastic mass of distilling coal would wind around the paddle shaft and paddles and gradually bake in place until it was impossible to get any more coal into the retort. Such is the inevitable result when a fusing coal is put into such a retort, and we may state as one of the fundamental facts of the art of low-temperature carbonization that any device for stirring a fusing coal during carbonization will inevitably become more and more heavily gummed up with carbon residue unless some positive mechanism be provided for removing this deposit. Likewise all simple revolving cylinder retorts will fail with fusing coal, and no amount



IRVINGTON EXPERIMENTAL PLANT

[1] See C. H. Smith patent, U. S., 1,224,424.

of argument on the part of their inventors will prevent the distilling coal from sticking on the sides of such a retort until it is plugged. Furthermore, all retorts involving the use of internal screws to agitate and convey the distilling coal will fail to handle a caking coal unless some means of keeping the screws clean be provided.

It must be recognized that caking coals, which fuse in the retort and pass through every stage from a fairly fluid mass to a brittle solid, act entirely differently from lignite or oil shale. Again and again retorts which have been used on lignite or shale are brought forward as suitable equipment for carbonizing all sorts of bituminous coals, and not one-half of 1 per cent of such retorts will operate at all on caking coals. Such was the lesson which Retort No. 1 taught, or tried to teach, almost daily for over a year at the Irvington plant. And it finally got the idea across, but not until dozens of tests had ended with a plugged retort and Retort No. 2 had been built along similar lines and had likewise failed.

Several other difficulties were made apparent during the course of the tests on Retort No. 1. The feed screw would frequently jam, due to a plug at the foot of the vertical section of the 7-in. feed pipe, this causing the pipe to fill up and very soon bind the screw with coal. When Retort No. 2 was built, early in 1916, the crushed coal was fed to the retort by a short plunger device at the floor level of the retort. This also gave much trouble. The problem of coal feed was eventually solved by using a 9-in. screw set horizontally and emptying directly into the retort through the end-plate, above the paddle shafts, as will be shown later in sketches of the Clinchfield type of retort. In this arrangement the retort paddles sweep past the discharge end of the feed screw and keep it free.

The single screw for discharging the carbon residue from Retort No. 1 was a failure. It would plug full of plastic carbon residue and cease discharging or break its driving mechanism. The single discharge screw was finally removed and two 6-in. screws were set in a brick discharge box at right angles to the axis of the retort. These also plugged. Nine-inch twin screws were then tried, and these worked a little better, but still the discharge would plug up frequently with plastic material. The 9-in. twin screws were next transferred to Retort No. 2, and Retort No. 1 rebuilt with a 24x36-in. cross bolted to the discharge end, with a 24-in. chute for discharging the carbon residue, the chute being closed with hand-operated slides. The slides became gummed up with heavy tar and could not be worked. A slide valve was then substituted for the hand-operated slides, but this also stuck and had to be abandoned. The problem of an entirely satisfactory discharge mechanism was never wholly solved at Irvington, although numerous schemes were tried out on the various retorts built and tested. The scheme finally adopted, known as the "Vesuvius discharge," is shown in the sketch of the Clinchfield retort, and subsequent experience with it has shown that it is a failure.

It must be borne in mind that during all of this first year of experimenting the idea was to operate the retort so as to yield plastic carbon residue and to briquet this residue without binder. It was not often that enough of the carbon residue could be made for use in briquetting tests. It was found impossible to control the operating conditions closely enough to get a continuous discharge of plastic material. An attempt to briquet the plastic material with a brick press failed, and the attempts to briquet it in roll presses were not very successful. Finally, in the summer of 1916, it was decided to abandon the plastic residue idea and to carry the carbonization to a non-plastic residue, later briquetting this residue with a suitable binder. Retort No. 1 was then provided with a hand-operated ram for breaking the carbon residue from between the paddles. This ram was a heavy I-beam which was run lengthwise through the retort at intervals, the paddles being stopped and the I-beam pushed between the rows of paddles. By frequent use of this ram and by carrying the carbonization past the plastic carbon residue stage, Retort No. 1 could occasionally be kept going for several hours before a breakdown, and in this way enough carbon residue was obtained for experimenting in briquetting, etc.

A Vertical Primary Retort

While Retort No. 1 was being tested, a vertical primary retort was set up and attempts made to operate it. Fig. 2 shows the essential features of this retort. Of the few utterly absurd pieces of apparatus built by the company, this vertical retort would easily take first rank. It is difficult to discover a single commendable feature in the whole apparatus, yet cur-

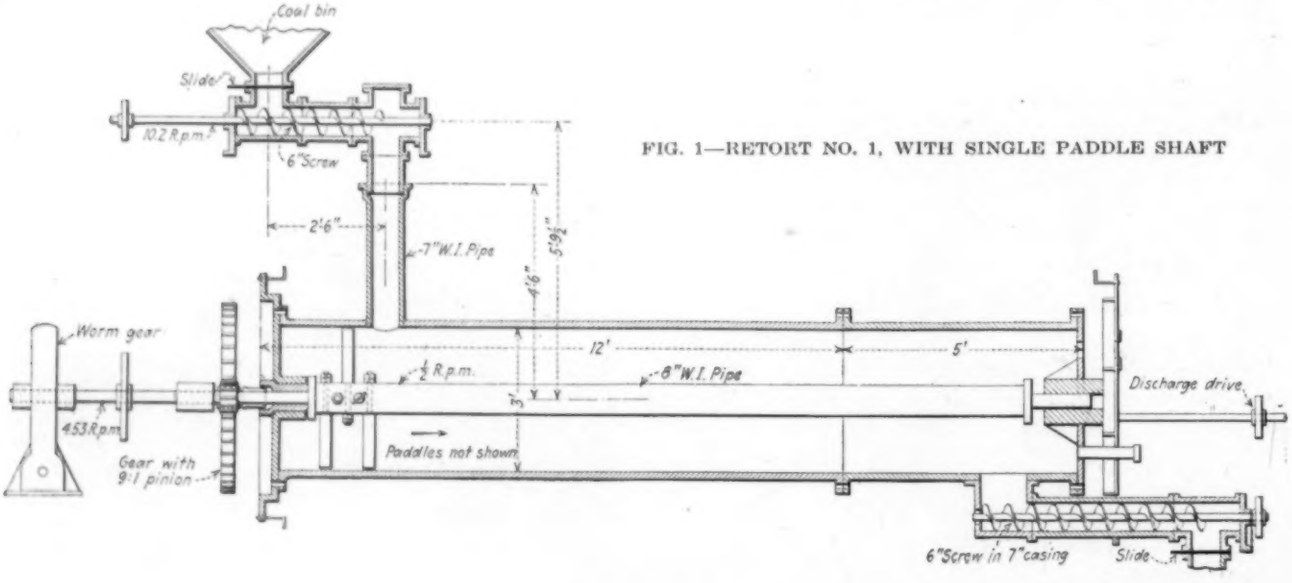


FIG. 1—RETORT NO. 1, WITH SINGLE PADDLE SHAFT

rent patent literature is replete with descriptions of no better retorts, and within the past few years one of the present authors has been asked to report on three low-temperature retorts involving most of the mistakes of this design. Any one familiar with the behavior of a fusing coal when distilled will note from a casual inspection of Fig. 2 that:

a. The feed pipe on this retort would plug as soon as the pipe got hot enough to begin even a very slow distillation of coal at its lower end.

b. That plastic coal mass would wrap around the paddle shaft and paddles and fill the retort so that no more coal could enter.

c. That the paddle shaft, paddles and driving mechanism are too high and would fail.

d. That plastic carbon residue would never get by the slide shown at the foot of the retort.

e. That even if plastic carbon residue got by this slide, it would soon wrap around the discharge screw and plug it.

f. That even if plastic carbon residue would pass the slide and the screw, it would stick in the elbow at the outer end of the screw.

g. That the gas offtake would have to be cleaned every few minutes.

h. That the slide at the bottom of the retort could not be moved after an hour or so of operation.

i. That the life of the metal retort would be short and that no provision is made for replacing it readily.

Retort No. 3

Retort No. 3, which is sketched in Fig. 3, was the first retort built with twin paddle shafts and self-cleaning paddles. This scheme of preventing carbon residue from plugging the retort was entirely successful and was used in all subsequent designs. The feed screw on this retort was located at the floor level of the retort, and gave trouble occasionally; it was eventually moved up so as to discharge above the level of the paddle shafts.

Retort No. 3 was also the first retort to be built with a carborundum lining, such as used later in the Clinchfield retorts. Carborundum possesses the advantages of strength and relatively high heat conductivity. It slowly deteriorates in an oxidizing atmosphere at 1,600 deg. F. (flue temperature), however, and although it was adopted for the commercial Carbocoal plant at Clinchfield, Va., it is probable that better material will be found eventually.

Retort No. 3 had heating flues running lengthwise the retort, with burners at the feed end. In operation it was found best not to use the burners across the top of the retort, and in subsequent designs no provision was made for heating the retort top.

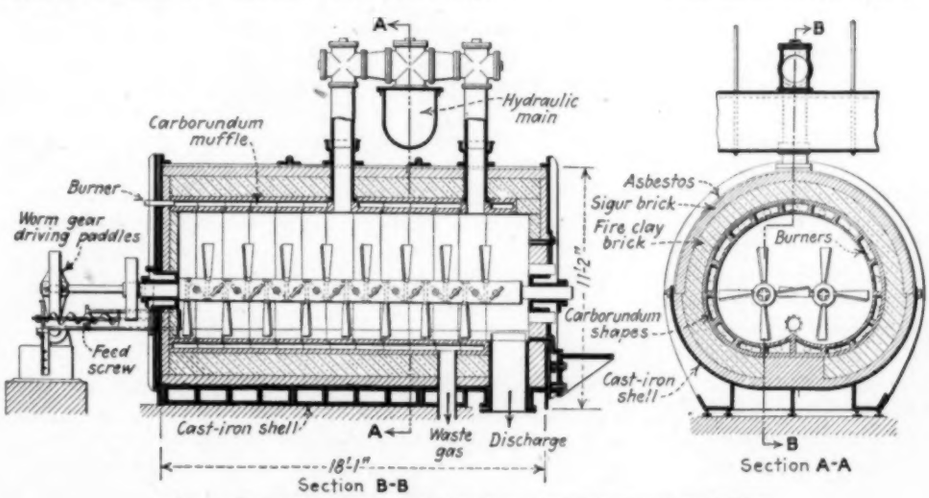


FIG. 3—RETORT NO. 3, EQUIPPED WITH TWIN PADDLE SHAFTS AND SELF-CLEANING PADDLES

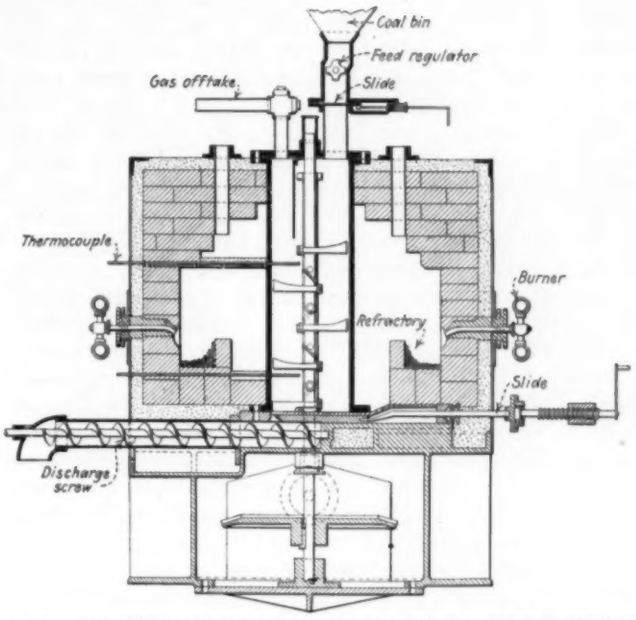


FIG. 2—VERTICAL RETORT, WITH SINGLE PADDLE SHAFT

The discharge chute dropped the carbon residue onto a pair of revolving breaker arms, which broke up the larger pieces, and then into a star-wheel which served to seal the retort partly. This discharge gave considerable trouble due to gumming of the star-wheel with heavy tar and plastic carbon residue.

The hydraulic main and gas offtakes on Retort No. 3 gave continuous trouble through plugging with pitch and coke deposit. This equipment was eventually abandoned in favor of the scrubber standpipe installed on the Clinchfield retort. It was proved at Clinchfield a few years later, however, that the successful operation of such a hydraulic main is a matter of using liquor sprays correctly.

In spite of the minor difficulties mentioned above, Retort No. 3 was fairly successful, whereas Retorts No. 1 and No. 2 and the vertical retort were complete failures. Retorts Nos. 4, 5, 6 and 7, and eventually the Clinchfield retort, were modeled more or less on Retort No. 3, with such changes as seemed desirable in the light of accumulating experience.

Retorts Nos. 4, 5, 6 and 7

These four retorts were the prototypes of the Clinchfield retort described below, and were all modeled on Retort No. 3. In Retort No. 4 the burners were placed in two rows along the bottom of the retort, with flues running ribwise around the retort and opening into a large open space over the whole top of retort. Later the heating system was rebuilt so as to run the flues from either side into two separate parallel sole flues running lengthwise the retort as in the Clinchfield retort shown in Fig. 4 below. This change was subsequently made on Retorts Nos. 5, 6 and 7 and the four retorts arranged as a battery.

Various types of gas offtakes were tried out on Retorts Nos. 4, 5, 6 and 7, but eventually all four retorts were equipped with the scrubber standpipe type, such as shown in Fig. 4.

For discharging the carbon residue, Retort No. 4 was equipped at first with a chute closed by a hand-operated barrel valve. Below the valve the carbon residue fell into a cast-iron cooling chamber, closed at the lower end by a hand-operated door through which it could finally be discharged to a conveyor. As may be guessed, the hand-operated barrel valve soon gummed up and could not be moved. The "Vesuvius" discharge, as later used on the Clinchfield retort, Fig. 4, was finally evolved. This included a pair of breaker arms, overlapping twin screws in a cast-iron casing, with a short vertical chute at the outer end of the screws. The carbon residue brought out by the screws was forced up over a curved floor into a vertical chute and then fell over a dam and down onto a conveyor. By thus forcing the carbon residue up into a short vertical chute, a partial seal over the ends of the discharge screws was secured. Retorts Nos. 5, 6 and 7 were also equipped with this discharge apparatus, and, very unfortunately, it was adopted for the Clinchfield plant.

Retort No. 9

Description of Retort No. 8 will be omitted, since this retort was never set up at Irvington, although it was designed.

Retort No. 9 was built of steel with steel supports which were designed to take care of the expansion of the metal. The essential features of this retort are shown in Fig. 5. Unfortunately, the supporting of the steel retort proved insufficient when the retort was heated and it soon warped so that the paddles dragged on the sides of the retort and it could not be further operated.

The failure of this retort discouraged further large-scale experiments with metal retorts, but small-scale tests have been continued and are still in progress at Clinchfield.

The Clinchfield Retort

The evolution of designs along the general lines of Retorts Nos. 3, 4, 5, 6 and 7 culminated in the Clinchfield retort, adopted for the commercial Carbocoal plant at Clinchfield, Va. This retort is shown in Fig. 4. Including furnace, machinery, etc., it is roughly 37 ft. long, 12 ft. wide and 27 ft. high, in over-all dimensions, while the heart-shaped muffle is 7 ft. 4 in. maximum width and 16 ft. long. The muffle is built of carborundum shapes, the total weight of carborundum per muffle being about 5 tons. The muffle is supported on fireclay saddles 18 in. apart, and is heated by two rows of ten open pipe burners supplied from a fuel gas manifold placed in a tunnel underneath the retort. Air for combustion is drawn through a recuperator, the amount of air to each burner being controlled by a damper block near the burner. There are ten combustion flues on each side of the retort, each set of flues leading to a common flue running lengthwise the retort on top, as shown in Section *B-B* of Fig. 4.

The paddle shafts and paddles are of cast steel, each paddle held in place by a single steel stud bolt passing through the shaft, the shaft being recessed for the nut and reinforced under the nut.

The carbon residue discharged from the retort falls down a vertical chute about 7 ft. long, at the bottom of which a pair of breaker arms crush the larger pieces of material so that it can be handled by the discharge screws. There are two of these screws in a common casing. At the outer end of the screws the carbon residue is pushed up a curved surface into a short vertical chute, and finally falls over a dam formed by cutting away the sides of the vertical chute. (This arrangement is known as the "Vesuvius discharge." See

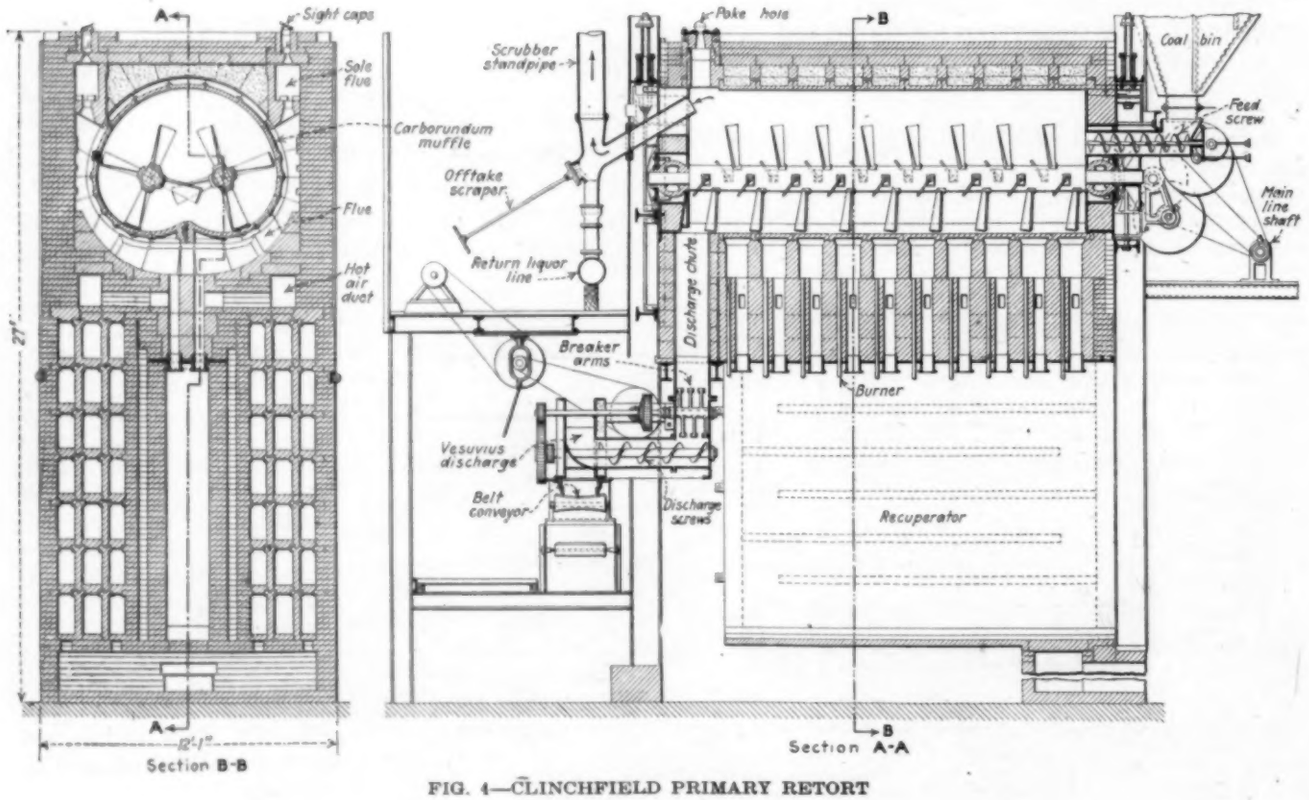


FIG. 4—CLINCHFIELD PRIMARY RETORT

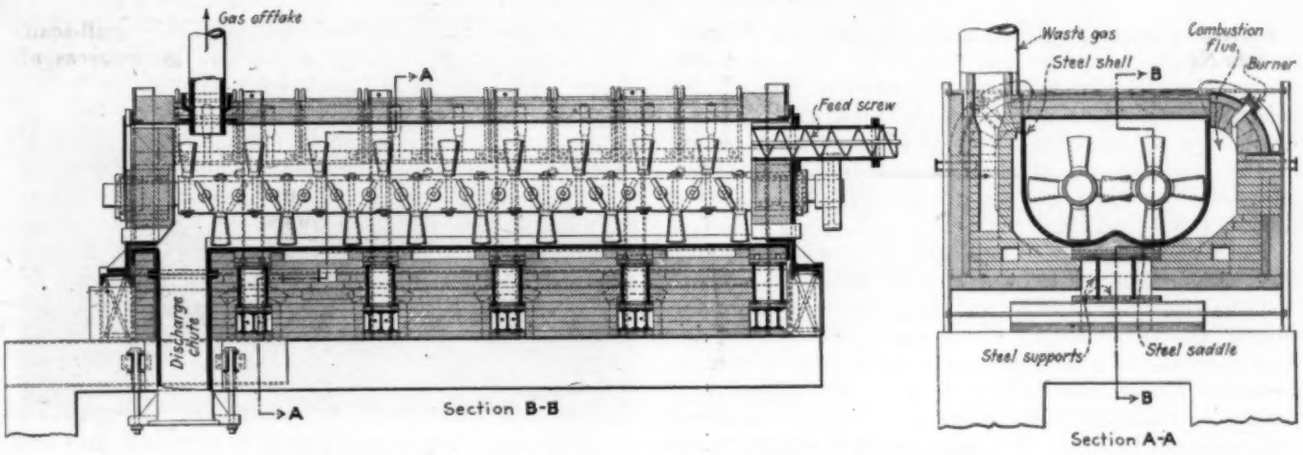


FIG. 5—RETORT NO. 9. STEEL MUFFLE IN FIREBRICK SETTING

reference to it in a later paper.) The carbon residue is carried away by rubber-covered conveyor belts.

The end plates of the muffle are suspended from the top, with means for adjusting the tension on the suspension bolts as the muffle changes elevation due to expansion of supporting masonry. The end plates, however, cannot be raised or lowered independently of the muffle.

At Clinchfield these retorts are built in four batteries of six retorts each, the feed ends of retorts are turned toward each other and four retorts are fed from a common coal bin. The feed screws and paddle shafts for twelve retorts are driven from a single 50-hp. motor.

In a subsequent paper in this series of articles the performance of this retort at the Clinchfield plant will be discussed and further details of construction mentioned. From perusal of Fig. 4 it will be evident that the retort was a costly one to build and those familiar with the art of low-temperature carbonization will readily foresee some of the operating difficulties encountered with this retort at Clinchfield.

Steel Plate Primary Retort

There are several reasons why a metal retort for carbonizing coal at low temperature would be desirable, the chief of these being, of course, the high heat conductivity of a metal compared to a refractory. One of the most serious difficulties in the project of low-temperature carbonization lies in the matter of heat transfer to the coal mass.

It was thought that if a muffle were built of rather thin steel stock, the temperature necessary in the heating flues might be so low that no damage would be done to the muffle. As a test of this idea, a heart-shape muffle was fabricated of half-inch boiler plate, with round about steel ribs, the joints in the muffle being welded. The muffle was essentially of the same dimensions as the carborundum muffle in Retort No. 4 and was substituted for this muffle.

The experiment was unsuccessful, the steel muffle soon warping until it interfered with the paddles.

Briquetting Carbon Residue

In the foregoing pages we have described various commercial retorts built and tested at Irvington, and the retort adopted for the Clinchfield plant. The evolution of a workable retort, however, was only a first step in the production of a marketable, smokeless fuel. The original plan of briquetting the carbon residue while it was still in a plastic condition proved unfeasible, and attention was next turned to methods of briquetting the non-plastic residue. This problem proved to be one of some difficulty also. The carbon residue as it comes from the retort, containing, say, 10 to 12 per cent of volatile, is a light, friable form of semi-coke, which readily begins to burn when exposed to the air. Various systems of handling this material were tried out at Irvington, including pan conveyors, air-jet conveyors and steam-jet conveyors.

The air-jet conveyor (Sims) was out of the question, due to its aggravating the fire trouble and to the difficulty of collecting the coke dust carried out of the bins by the air. The steam-jet was more satisfactory, but was also impractical on account of the very high steam consumption. The pan conveyor was satisfactory so far as carrying the carbon residue was concerned. It was found that the carbon residue could not be stored for longer than about an hour unless it were very thoroughly quenched, and if this were done the wet material would clog the grinding mills. The ground material, however, could be stored for some time without catching fire.

The system finally used at Irvington was to grind the hot, dry carbon residue within an hour or so after it left the retort. The ground material was then stored in a steel bin until briquetted. The ground carbon residue shows little or no tendency to burn explosively, even when ground so that 50 per cent of it will pass a screen of 100-mesh per linear inch.

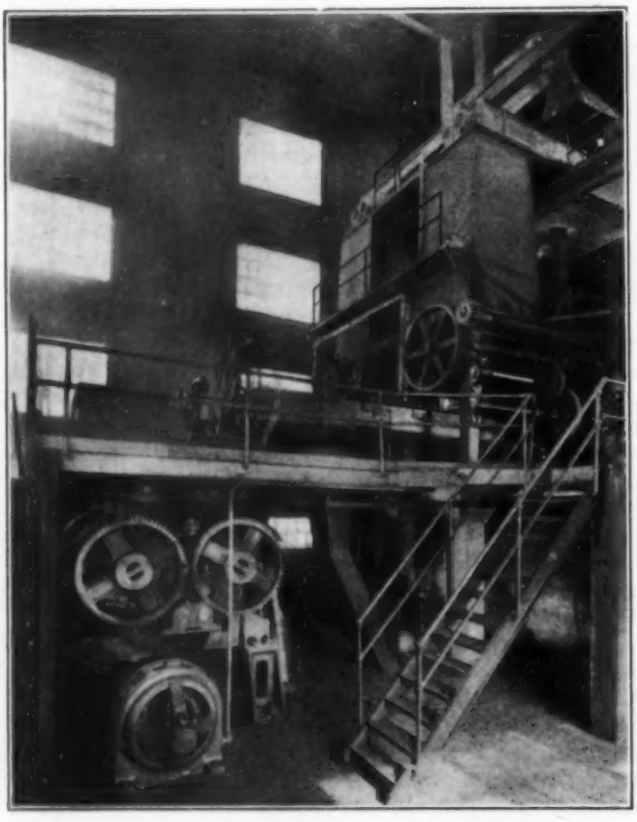
The first step in briquetting carbon residue is the proper grinding of the material. There were tried out at Irvington a Williams hammer mill, a roll crusher and a Mashek hammer mill. None of these was satisfactory. The roll crusher did not give a satisfactory distribution of screen sizes in the ground material, and the hammers on the hammer mill would not stand up under the abrasive action of the carbon residue. The problem of grinding carbon residue was not solved at Irvington. At the Clinchfield plant hammer mills were installed, despite the Irvington experience, and when these failed completely, ball mills were used successfully.

After proper grinding it is a simple matter to flux the ground carbon residue with a binder and briquet it. The percentage of binder required is higher than for coal, and the pressure required in the press somewhat greater, but in general the same principles apply. At Irvington a Belgian type roll press was used successfully. This press formed thin oval briquets, however, and it was thought that a more nearly

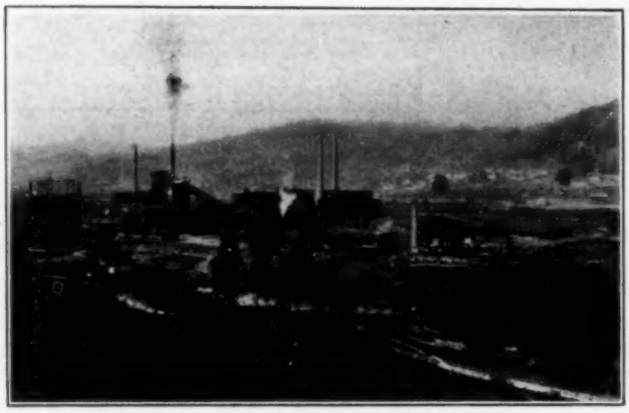
spherical briquet was preferable. To meet this requirement a Komarek press was installed. This is a roll press in which flat-link chains run over one of the rolls, between the rows of briquet dies, yielding oval briquets with flat ends. This press gave good results in the experimental plant at Irvington. It was less successful at Clinchfield when used there later, due to excessive wear on the liner chains.

The briquets formed from carbon residue with suitable binder can be shipped and marketed. They are not smokeless, of course, and if pitch be used as the binder, the tarry smoke which distills out during the first few minutes on the fire is disagreeable and is likely to cause trouble from fires in the chimneys if used in ordinary household stoves. After the briquets have been on the fire a few minutes, however, the pitch has distilled out and the briquets then burn slowly and without smoke.

It was recognized at Irvington that, although briquetting the carbon residue converted it into a salable product, these raw briquets did not represent an ideal solution of the problem. By heating the raw briquets in a muffle it was found that they could be rendered smokeless and an appreciable yield of byproducts obtained. It was discovered, also, that the carbonizing of the raw briquets at high red heat not only rendered them smokeless by distilling out the pitch, as might be expected, but it also changed the internal condition of the briquets so that a finished briquet has a continuous structure, whereas in a raw briquet there are discrete particles of carbon residue cemented by minute globules of pitch. During carbonizing, the particles of carbon residue link to one another more or less firmly. The Carbocoal briquet is harder and denser than the raw briquet, the shrinkage in volume during carbonization being anywhere from 10 to 30 per cent. It



GENERAL VIEW IN BRIQUET HOUSE



GENERAL VIEW OF CLINCHFIELD PLANT AND VILLAGE

was also discovered that the quality of the Carbocoal is dependent to a remarkable degree on the make-up of the raw briquet. There are apparently several factors involved and it became evident that briquetting carbon residue for subsequent carbonization was quite a different proposition and a decidedly more complex proposition than the mere binding of coal or of carbon residue into raw briquets. During the past 5 years experiments in briquetting and carbonizing have been under way continuously. We plan to publish at some later date a summary of the several hundred experiments completed. Suffice it to say here that we now know the general influence of the following factors in the problem:

a. Coking quality of the original coal.
b. Volatile left in carbon residue.
c. Screen analysis of the ground carbon residue before briquetting.
d. Composition of raw briquet mix.
e. Quality and screen analysis of any raw coal added to raw briquet mix.
f. Kind of binder and melting point of same.
g. Method of fluxing, time in fluxer, temperature in fluxer and water in final briquet mix.
h. Temperature of material fed to press.
i. Kind of press used, pressure, shape of briquet, condition of briquet surface.
j. Rate of heating briquet in secondary retort, final temperature reached, time of carbonization, height of briquet charge in the retort.
k. Time between discharging of briquets from secondaries and quenching. Method of quenching.

Not all of these factors are independent of one another, but it is necessary to control each of them within certain ranges which it has been our endeavor to determine.

Carbonizing Raw Briquets

Several commercial retorts for carbonizing briquets were built and tested at the Irvington plant during the 6 years of experimental work there. It was found that ordinary D-shape gas retorts would carbonize the briquet satisfactorily in a few hours, but it was difficult to charge and discharge such retorts with briquets. A Glover-West vertical retort was built and tried, but the column of briquets in this was too high and the briquets at the bottom of the column were crushed before they hardened.

Inclined retorts were finally tried and operated with some success, although there was always some breakage in charging the retorts, and it was very seldom that a charge of carbonized briquets would roll out of a retort without poking it with rods. The secondary retort finally adopted for the Clinchfield plant was of rectangular section, divided into an upper and a lower chamber

by a silica brick partition, each chamber being roughly 4 ft. high, and 25 ft. long, 14 in. wide at the charge and 16 in. wide at the discharge end. The retorts were heated by gas burners, set at the top of vertical flues, the waste gases passing through a recuperator system before entering the main flue.

The main trouble with these retorts was that the column of briquets was too deep and the breakage of briquets was excessive. When the raw briquets were exceptionally good and other conditions very favorable, these secondary retorts would yield fair results, but under the normal conditions of operation they were outside the limits of workable equipment. The experience with these retorts at Clinchfield will be mentioned in a subsequent paper.

Summary

We have described briefly in the foregoing pages the general features of the several primary or low-temperature retorts built and tested at Irvington, N. J., and the evolution of the Clinchfield retort. Mention has been made of the methods tried out in handling the carbon residue from the retorts and the means used to convert it eventually into a fuel resembling anthracite in properties. It has not been possible to make this paper a record of the very numerous minor experiments which were carried out with the low-temperature retorts and with other equipment developed for the Carbocoal process. The program at Irvington also covered a considerable number of subjects connected more or less closely with the Carbocoal process but which lie outside the scope of this paper.

The experimental work at Irvington had been under way for a little over three years when the U. S. Government decided to finance a commercial Carbocoal plant at Clinchfield, Va. The Irvington plant had grown to be a semi-commercial plant meanwhile, with several primary retorts, a complete system for handling the carbon residue, grinding and briquetting equipment, two benches of secondary retorts, screening and loading station for Carbocoal, byproduct units and tar distilling plant.

At the time the Clinchfield plant was constructed complete solutions had not been found for all the problems in the process, but it was thought that the equipment which had been developed would be reasonably satisfactory in a commercial plant. We shall close this paper with a summary of the data available for design of a commercial Carbocoal plant at that time. In the third paper of this series we shall discuss the operation of the Clinchfield plant which was presumably built on the basis of Irvington experience.

In setting down the following items of data available for plant design, it must be recognized that personal judgments come into play. We have endeavored here to reflect the general opinion of men who actually directed operation at Irvington, checking these general conclusions against the operation records.

1. The equipment for handling the coal up to the primary retort, including the track hopper, apron conveyor, Williams hammer mill, bucket elevator and distributing conveyor was entirely satisfactory. The general scheme was adopted for the Clinchfield plant and proved satisfactory there.
2. The proposition of using twin paddle shafts and self-cleaning paddles to avoid plugging of primary retorts by plastic coal mass was entirely satisfactory and subsequent experience at Clinchfield has confirmed the correctness of this design.
3. The single helical screw, carrying coal into the retort above the paddle shafts, was found satisfactory. The same arrangement later proved efficient at Clinchfield.
4. Carborundum blocks proved satisfactory as material for primary retorts at Irvington, being strong enough to permit relatively thin walls and having a high heat conductivity. At Clinchfield later experience has shown that the slow oxidation of the blocks is a serious drawback.
5. The heating system for primary retorts as finally adopted at Irvington was fairly satisfactory, and Clinchfield experience has not added materially to what was known at Irvington. Better methods of heating a primary retort have been developed since Clinchfield construction, however, as will be shown in subsequent papers.
6. As a result of many experiments on discharge mechanisms for the primary retorts, the scheme finally adopted was to drop the carbon residue down a vertical chute onto a pair of revolving breaker arms, below which a pair of helical screws carried it out several feet and forced it up over a dam. This mechanism later proved to be a failure.
7. It was known at Irvington that a carbon deposit formed on the inner walls of the primary retort and that eventually this deposit hardened so as to interfere with the paddles. It was thought, however, that a retort would not have to be cleaned out more than twice a year. This conclusion proved erroneous in Clinchfield operation.
8. It was found at Irvington that the gas offtakes from the primary retorts would plug and had to be reamed out at frequent intervals. This reaming proved troublesome at Clinchfield later.
9. At Irvington the air jet conveyor was shown to be worthless for carrying carbon residue and the steam jet conveyor was found to be extravagant of steam. The pan conveyor gave some trouble mechanically, but was otherwise successful. None of these schemes was adopted for Clinchfield.
10. It was shown at Irvington that it is impractical to store warm unground carbon residue, since it soon begins to burn. This experience was disregarded in Clinchfield design.
11. It was shown at Irvington that hammer mills are not satisfactory for grinding carbon residue. This experience was disregarded in Clinchfield design.
12. The method of proportioning the raw briquet mix worked out at Irvington included a slide-gate with a drag chain conveyor for the ground carbon residue and a weir for the molten pitch. This arrangement was used at Clinchfield. It never gave real control of the proportions of carbon residue and pitch.
13. The Komarek briquet press with flat-link chains running between the dies was adopted at Irvington. It operated well at Clinchfield, but the wear on the chains was excessive.
14. The link-chain cooling conveyor for briquets as they came from the press was satisfactory at Irvington and later proved so at Clinchfield.
15. It was known at Irvington that raw briquets must be handled with reasonable care to avoid excessive breakage. This information was disregarded in Clinchfield design.
16. It was known at Irvington that raw briquets when stored in bins have a tendency to stick together and refuse to flow out of the bin through a discharge door. Large storage bins were installed at Clinchfield.
17. The inclined secondary retorts developed at Irvington were not entirely satisfactory there and proved less so at Clinchfield. It was very rarely that a charge of finished briquets would roll out of the retorts without considerable poking and the breakage was usually high. Several of the factors affecting the quality of the Carbocoal were recognized at Irvington.

Contraction and Shrinkage of Aluminum Alloys

As the result of an investigation of the contraction and shrinkage of aluminum alloys conducted by Robert J. Anderson, metallurgist, at the Pittsburgh, Pa., experiment station of the Bureau of Mines, it has been shown that contraction of a series of forty alloys varied from 0.96 and 1.80 per cent, depending upon conditions, and that it is advisable to make accurate pattern allowances for the various alloys in casting practice.

A Longer College Course for Engineers

By F. E. Turneaure

Dean, College of Mechanics and Engineering, University of Wisconsin

[*Apropos recent editorial comments on engineering education for metallurgists and chemists, and correspondence on those matters published in the department headed "Readers' Views and Comments," the following exposition of the longer engineering curriculum by Dean Turneaure will be illuminating. It was contributed to the December, 1922, issue of the Bulletin of the Society for the Promotion of Engineering Education.*]

IT SEEMS to me that, broadly speaking, the most important problem before the engineering schools is the old one: What are the requirements which should be met by the engineering school, and how should the curriculum, teaching staff, etc., be organized to meet these requirements? In suggesting this fundamental problem, I am of the opinion that it has never been adequately studied, and that a properly constituted board can do a great deal to crystallize opinion in regard to this very fundamental problem. Perhaps a statement of some of my own notions will explain what I have in mind as to past defects and future possibilities.

Qualifications Demanded for Engineers

First, in regard to requirements of the present day in the matter of the school training of engineers: In attempting to answer this question, a great many fields of engineering activity should be considered. The question cannot be answered by the broad statement that engineers should be trained like lawyers or doctors and that, engineering being a profession, the training should preferably consist of general college courses followed by professional courses requiring altogether 6 or 7 years. I think a certain class of engineers and educators is inclined to consider that this is the ultimate and inevitably correct solution. There are, on the other hand, a good many teachers and also engineers who consider that for many lines of practice a 4-year school period is long enough and that the young man will do better to get into practical work than to remain longer in college. I have myself seen considerable evidence of the truth of the latter position. It is my belief that the technical requirements of an engineer and an engineering education vary over a comparatively wide range and that a careful study of the situation with especial reference to this point will give us some really useful information.

I think this problem can be divided into two parts: (*a*) How much general education should an engineer have, and (*b*) How much technical education should he have? In attempting to answer these questions, all branches of engineering practice should be thoroughly studied and very definite inquiries should be made of men in practice who understand exactly what is wanted. The actual needs of men in various lines of engineering activity should be considered. Highly technical specialties should be recognized as such, and the proportion of engineers in various kinds of work should be information of significance in this connection.

As an illustration of what I have in mind, consider the practice of highway engineering at the present time. A very large number of men are required at this work, and a large percentage of these men are not engaged (at least for many years) in a kind of work which involves a very large amount of technical schooling. The work of the young engineer, from the technical standpoint, is quite simple, and likely to be so for many years —in fact, the business phase of the work is perhaps of more importance than the engineering phase, especially for men in the more responsible positions. It is true, also, that for certain classes of work an engineer should have a very thorough training in structural design or in bituminous pavements, geology, etc., but the number of men needed for this kind of work is comparatively small, and some of this highly specialized work may well be considered in the category of specialization.

Minor Branches of Engineering

Then there are many other varieties of engineers whose preparation does not need to be highly technical, such as the operating engineers, contracting engineers and, in a sense, railroad engineers. In the various industries there are certainly many lines of work where the technical requirements are not high but where business sense and judgment count more. I believe an effort should be made to analyze requirements very thoroughly along some such line as above suggested.

It is my belief that the time has arrived when it may be expected that any young man desiring to enter any engineering employment, however simple, ought to secure, if possible, a college training of 4 years in length. With the tremendous increase in the high school and college attendance throughout the country and the increasing ease with which young people can secure a college education, I believe that such an education should be required of any young man who goes into a business or profession where he expects, sooner or later, to exert considerable influence with his colleagues or with the public. A college education no longer is an uncommon thing. I am impressed with that fact in looking over our recently published alumni directory and noting the large number of university graduates located in all the smaller cities and many of the villages throughout the state. This number is bound to increase, and an engineering representative of the highway commission in any neighborhood, or the village or city engineer, should be a man who can acquire a standing with the best in the community. It is my belief, therefore, that a 4-year college course of some kind should be the minimum set before the young man as a preparation for any line of engineering.

It is quite true that the technical requirements of some lines of work may be met by means of short courses of 2 or 3 years in length, and that question was discussed by our faculty some years ago. We reached the conclusion that 2-year courses would well satisfy the technical requirements for quite a variety of employment, but did not consider it the function of the university to establish such courses.

Four-Year Course the Minimum

If it is decided that a 4-year college course is sufficient to meet the requirements for general education plus minimum technical requirements, then the problem resolves itself into that of determining the higher technical requirements and how they are to be met in the school: whether by a combination liberal arts course plus graduate work in engineering, or by a 5- or 6-year combination course carrying some engineering work throughout the period. At present our standard 4-year

engineering course as given in most schools is, in my judgment, of a quality which is neither hay nor grass; it cannot be considered a course for a broad education, neither can it be considered a very satisfactory course for those desiring the most advanced training. The first-named objection is more serious than the latter, because a student desiring advanced technical work can get it in graduate study; but the lack of breadth cannot be so easily remedied by the individual student.

To indicate more clearly what I have in mind as to the direction for this phase of the investigation, I might outline what seems to me to be a fairly good solution, and the reasons therefor.

Pre-Engineering Courses

In brief, this would consider a 4-year engineering course (or pre-engineering course) which would be very general in its character. It would contain a large amount of work of general educational value, such as history, economics, language, science, chemistry, physics, mathematics and mechanics, also the elements in applied work in the usual branches of engineering. Such a course I would consider the minimum requirement for any young man who desires to enter the industries or any field of engineering whatever; and for many lines of work it would be a satisfactory preparation. It would also furnish a sufficient foundation in mathematics and science to enable a man of real ability to advance himself in almost any line of engineering activity, even where a longer course of training would be preferable. By the elimination or postponement of a very considerable amount of technical studies, now included in the regular 4-year course, such a course as above indicated could be made quite satisfactory from the standpoint of general education and, on the whole, much more satisfactory than a 4-year course in a college of liberal arts such as would be elected by students planning on an engineering course later. At least it would meet the needs of a great many more students, and I am inclined to think that it would be the best course for practically all.

The 4-year course as above indicated should lead to a degree (such as the B.S. degree), without special designation. Then those students who desire a more thorough engineering education should secure it by further study, either in the form of graduate work or fifth- and sixth-year courses leading to an appropriate second degree. These advanced courses would be well organized, and would be taken by a very considerable number of students, as they would contain a good share of the material now included in our senior year. They would naturally be taken by all students desiring to enter the research field and those aiming to become fairly well posted in any special line. I should suppose that from 25 to 40 per cent of those finishing the 4-year course would continue for a fifth or sixth year, the percentage depending, of course, quite largely upon the curriculum adopted.

Among the advantages of such a scheme as above suggested are possibly the following:

1. It requires all engineering students to secure a much broader general education than is now the case, while at the same time it includes a sufficient amount of fundamental technical work to satisfy the requirements in many cases.

2. It furnishes the well-organized technical work for special and advanced students which will encourage students of ability to thoroughly prepare themselves for research and special work of various kinds. Graduate courses in engineering will be much better organized than is now the case.

3. It is a better arrangement than that frequently proposed of requiring a 2- or 3- or 4-year college course before admission to the engineering school. In any pre-engineering course, a considerable amount of mathematics and science must be required in order to save time, and pre-engineering courses under the control and advice of the engineering faculty can be better adjusted to the students' need than when otherwise administered.

4. It would, I believe, solve the problem of the 4-year course, against which so much criticism is directed.

5. It would tend to eliminate from the more advanced and technical work students who are unfitted for such work while at the same time capable of becoming successful engineers in certain lines of employment. With the very great numbers now attending engineering schools, a relief of work in the senior and junior laboratories would be very acceptable in most cases.

There are, of course, many other phases of this study but I believe the very first thing to be done is to determine upon some reasonable solution of the problems above discussed. Engineering faculties are, I feel sure, quite capable of determining upon details and methods of teaching. They are also, in most cases, in very close touch with practicing engineers among their alumni and include among their members many men with considerable engineering practice. I do not believe, therefore, that it is necessary to go far into details. On the other hand, it is true that engineering teachers are, as a whole, quite concerned over the situation, and are prepared to follow the lead of a strong report which will clearly set forth requirements and a way to meet them under the conditions actually existing in the majority of engineering schools. We, I think, are ready to move, but we want to move in reasonable unison, and in a direction that it will not be necessary to retrace in the near future.

European Attempts to Number Steel

Progress Made by Switzerland, Germany and France Toward Standardization

A RECENT conference held in Washington discussed the desirability and possibility of devising some system of numbering whereby kinds or qualities of steel can be designated by code numbers. Lawford H. Fry, of the Standard Steel Works Co., presented a résumé of European practice, as revealed by correspondence with various foreign organizations. It appears that Switzerland, Germany and France have made some attempts to establish such a code.

The Swiss system attempts to show the content of the carbon and of the principal alloys by using the chemical symbol of the elements and adding to each a figure showing the mean percentage. Thus a carbon steel with 0.25 to 0.35 per cent carbon has as its symbol C2n. The suffix "n" shows a maximum allowable content of 0.07 per cent phosphorus and 0.06 per cent sulphur. If the steel is given the symbol C2s, the maximum allowable is 0.04 per cent phosphorus and 0.03 sulphur. If the symbol is written C2 without suffix, neither may exceed 0.02 per cent.

In this manner all steels are classified on the basis of their chemical properties. It does not take into con-

sideration either the manufacturing process (whether open-hearth, electric or crucible) or the use to which the metal is designed to be put—such as rail steel, firebox steel, and so on.

For a chromium-nickel steel with 0.25 to 0.40 C, 2.5 minimum Ni and 0.60 to 0.90 Cr, the symbol is 3-Ni30-Cr8. In the alloy steels the C for carbon is omitted, but the first figure "3" shows a mean carbon content of three-tenths per cent, the Ni30 a mean nickel content of 30-tenths per cent and the Cr8 a mean chromium content of eight-tenths per cent. Following the chemical composition symbols a note is added when the steel is to be annealed or treated, and in the latter case the minimum tensile strength in kilograms per square millimeter is given. Thus the complete designation of the above nickel-chromium steel would be 3-Ni30-Cr8 treated to 80. The standard sheets show the yield point, elongation and notch toughness corresponding to this tensile strength, and these may, if desired, be added to the symbol in ordering.

If the symbol gives no information regarding the condition, it means that it will be received after ordinary slow cooling from the last forging or rolling process. When special attention must be given to other properties, the person specifying must select the correct alloy by reference to the standards. Thus a steel with 80 to 90 kg. per sq.mm. tensile strength (115,000 to 130,000 lb. per sq.in.) can be met by a plain carbon steel. However, if elongation must not be less than 12 per cent, then a nickel steel would be chosen (3-Ni30 treated to 80). If in addition a yield point of at least 85,000 lb. per sq.in. is required, "3-Ni30-Cr8 treated to 80" may be selected.

It appears to Mr. Fry that the Swiss code is open to serious objections unless it is used in close connection with a series of standard specifications. If a symbol standing alone is to be interpreted, misunderstandings may occur. For example: Since the average carbon content is rounded off to the nearest one-tenth per cent, the symbol C4 may indicate a carbon steel with a carbon range from 0.30 to 0.40 per cent (mean 0.35), or with a range from 0.39 to 0.49 per cent, (mean 0.44). Further, in the steels now listed the manganese content varies without any indication of this being given in the symbol.

The system is stated to be capable of indefinite expansion and yet to indicate definitely the steel desired. It appears to Mr. Fry that in practical work much confusion will occur unless the symbols are used in direct connection with the standard sheets.

GERMANY

An industrial standards committee has issued a bulletin covering steels without alloys and untreated. Seven grades are listed, for which tensile strength and elongation in the annealed condition are specified by arbitrary numbers with the prefix St.

Designation	Tensile Strength, Kg. Per Sq. Mm.	Elong. in 100 Mm., Per Cent
St. 0	Not specified	Not specified
St. –	34-44	25
St. 1	34-42	30
St. 2	42-50	24
St. 3	50-60	22
St. 4	60-70	17
St. 5	70-80	12

The German committee doubts whether it will be practicable to classify all steels in a continuously numbered series. It will possibly be desirable to separate carbon from alloy steels so that a basic number related to the carbon content can be carried through while the alloy steels receive a distinguishing mark.

Another interesting attempt has been made by the Bavarian Motor Works[1]. It follows somewhat the American Society of Automotive Engineers' system. The first digit of their number corresponds to the degree and kind of alloy; thus, 1 represents carbon steels, 2 a low alloy, 3 represents nickel steels, 4 nickel-chromium, 5 nickel-tungsten, 6 high chromium—greater than 1½ per cent. The second digit represents the carbon content in tenths of 1 per cent. Finally letters are added, designating the quality: *a* for first class construction steels, *b* for standard open-hearth steel, and *c* for ordinary commercial steel of moderate strength. Low-alloy steels of class 2 are all presumably of *a* quality, for these letters are replaced by others representing the alloy content. By this scheme steel 12b represents a plain basic open-hearth steel, S and P up to 0.05 per cent, containing 0.16 to 0.25 per cent carbon. On the other hand, 21m/s is a silico-manganese steel (Mn over 1 per cent, Si over 0.5 per cent), with carbon up to 0.15; 42a will be an electric furnace nickel-chromium steel, Ni about 3.5 per cent, Cr about 1.5, C, 0.25 and Mn 0.4 per cent.

Such a scheme is said to be coming into use by the German Society of Automotive Manufacturers, but evidently a user of the code must always have an explanatory table showing composition limits and physical properties.

FRANCE

A permanent commission for standardization in France has issued a series of specifications for carbon steel bars, blooms, billets and slabs in five classes of steel. No chemical composition is given, but in each specification the steel is divided into grades according to the minimum tensile strength. The numbers of the specifications, the class of material and the grades are shown below:

A_T-1-UF. Ordinary stock material. Grades by minimum tensile strength of an annealed bar: 35, 40, 48, 55, 70 kilograms per square millimeter.

A_T-2-UF. Material furnished in heat-treated condition. Grades by minimum tensile strength of bar from material as furnished: 35, 40, 48, 55, 70, 80, 90, 100 kilograms per square millimeter.

A_T-3-UF. Material to be heat-treated after delivery. Grades by minimum tensile strength from heat-treated bar: 60, 70, 80, 90, 100, 115 kilograms per square millimeter.

A_T-4-UF. Low-carbon steel for carburizing. One grade only, no tensile.

A_T-5-UF. Low-carbon mild steel. Grades by minimum tensile strength of annealed test specimens: 35, 38 kilograms per square millimeter.

The steels meeting these five specifications are to be marked to indicate the material as follows:

(1) The number of the specification as given above.

(2) A letter indicating the method of manufacture: M—acid open hearth (Martin). C—crucible. E—electric. B—bessemer acid. T—basic open hearth (Thomas).

(3) The number showing the minimum tensile strength specified.

The French Standards Commission, following the advice of the Committee of Arts and Manufacture consulting with it, accepted the principle that symbols in code should not be used. It has therefore arranged its system to designate beyond question a definite grade of steel covered by a complete specification. It appears to Mr. Fry that this principle is sound. A code which is designed to be extensible must lead to ambiguities as it is drawn out to cover new steels.

---

[1]Described in *Iron Age*, Nov. 9, 1922, p. 1199.

The Nature of Solid Solutions

Solid Solutions Usually Exhibit Space Lattices of Their Dominant Member, Slightly Distorted—In Some Systems the Transition Zones Show Two Co-existing Lattices Where Atoms of Each Constituent Replace the Others in Its Own Space Lattice

By Edgar C. Bain, M.Sc.
General Electric Co., Cleveland, Ohio

ENGLISH-SPEAKING scientists have chosen the words "solid solution" to denote the specific state of association of two or more substances entirely homogeneous in the solid. The name has points of merit, even though in some respects the properties of solutions are not apparent. The fact that such solids are capable of a considerable change in constitution and temperature without entailing any phase change urges us to this name. The German "mischkristall" gives us a fine conception of the condition structurally, but unfortunately is translated[1] literally "mixed crystals," which does not give us a picture of the solid solution, but more probably calls to mind a mechanical mixture of two kinds of crystals. If we translate "mischkristall" as "miscible crystal" we get a very clear picture of the condition. Recent investigations of metals with the X-rays[2] have brought out much information about the arrangement of the atoms themselves and the relation of this arrangement to the properties of the aggregate, and naturally the baffling condition of solid solubility has attracted extensive study by this same means. To this end many crystallograms of a great variety of solid solutions have been made in the author's laboratory and the results are here described.

The atomic arrangements of the metals and metalloids have been largely investigated and are shown in Fig. 2, with models of the space lattice types. The reader is requested to refer to this figure as various metals are mentioned.

Binary Solid Solutions

Many pairs of metals are entirely miscible in the liquid state in all proportions, just as are alcohol and water. Some others have such partial miscibility as have phenol and water, the solubility of *A* in *B* and of *B* in *A* increasing continuously with elevation of temperature. Rarely we find metals which exhibit little or no miscibility in the liquid state.

But there is the more interesting phenomenon of solid miscibility, very frequent in metals but having fewer examples in the non-metals and compounds.[3] With proper annealing two metals which have this mutual property become chemically homogeneous and resemble a pure metal; under the microscope the polyhdral grains are as uniform as a pure metal. But they freeze over a range instead of at a constant temperature; this is a concomitant with the phenomenon of "coring," a complex condition which will be discussed in a second contribution.

It was early discovered[4] that *when a metal A acts as a solvent in taking up metal B in the solid state, the atoms of B replace atoms of A in the A space lattice.* This substitution seems invariably to alter the parameter of the lattice slightly, but never its type until such a quantity is added as will exceed the limit of solid solubility, at which point a new lattice is formed compatible with the increased atomic ratio. This new phase usually involves the formation of a compound, and the metal begins to assume the lattice characteristic of the compound. (We shall consider later the few cases where no new phase appears between pure *A* and pure *B*, series known as continuous solid solutions or isomorphous series.)

As examples of limited solubility in the solid state we have investigated tin, zinc, manganese and aluminum as solutes in copper as solvent; cadmium and zinc in silver; tungsten, molybdenum, chromium and manganese dissolved in iron. The following data refer to the completely annealed or homogenized condition.

Copper-Zinc

When 30 per cent of the atoms of copper (face-centered cubic) are replaced by zinc atoms to form common alpha brass, the lattice is stretched so that

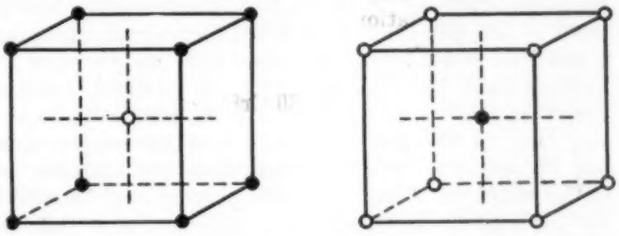


FIG. 1—COMPLEMENTARY SIMPLE CUBES OF 1:1 SOLID SOLUTION IN THE BODY-CENTERED CUBIC ARRANGEMENT

Light circles represent one kind of atoms and solid spots the other.

the fundamental cube edge *a* is increased from 3.60 Angstrom units to 3.68 A.u., a linear change of nearly 2.2 per cent, or a volume increase of 6.7 per cent in the unit cube. Computing density from atomic spacing and absolute weights of atoms (the hydrogen atom weighs 1.662×10^{-24} grams) we obtain the value of 8.54 as compared to the actually determined value[5] of 8.533.

When zinc is added to copper in excess of about 35 atomic per cent the face-centered lattice is inadequate to absorb it even at room temperature—the electronic distributions or interatomic forces find equilibrium in a body-centered cubic structure. The alloys in the narrow range around equal atomic proportions can be cooled slowly to room temperature, giving what appears under the microscope as homogeneous grains of β brass. The X-ray study shows that the large grains thus produced are truly of a single lattice. The conclusion is then that the structure is as shown in Fig. 1. Either sketch represents the conditions, since the central atoms in one series of cubes build themselves into corners of another series of interpenetrating cubes of exactly the same size. Centers become corners, and *vice versa*, as desired. Further additions of zinc produce a rhombo-

[1] See "Metallography," Part I, Principles, by S. L. Hoyt, p. 14.

[2] The method of determining atomic arrangement by X-ray diffraction has been described frequently. Hull, *Phys. Rev.*, vol. 10, No. 6, December, 1917. Bain, *Chem. & Met.*, Oct. 5, 1921.

[3] Above 300 or 400 deg. C. NaCl and KCl appear to have complete miscibility in the solid.

[4] *Chem. & Met.*, Oct. 5, 1921, p. 663, "Studies of Crystal Structure With X-Rays," Edgar C. Bain

[5] Private communication from F. G. Smith, American Brass Co., Waterbury, Conn.

hedral lattice and a structure[6] which has no ductility (γ brass). The structure of the limited η series of very rich zinc alloys is what might be predicted. They consist of the hexagonal zinc lattice in which copper atoms replace a few of the zinc atoms. In interpreting these results in terms of α, β, γ and other brasses represented on the equilibrium diagram, it should be remembered that the ranges for the different crystalline types as established by the X-rays do not correspond accurately with the divisions in the ordinary constitutional diagram drawn from thermal and microscopic investigations.

Copper-Tin

A 90:10 copper-tin bronze has an atomic ratio of 94.98 Cu to 5.02 Sn. The 5 per cent of tin atoms are over two-thirds as effective in stretching the copper lattice in the alpha bronze as the 30 per cent of zinc atoms in alpha brass. The cube edge of the space lattice for copper is elongated from 3.60 to 3.655 A.u., a linear change of 1.53 per cent, or a volume change of about 4.6 per cent. The absolute or theoretical density calculated from atom weights and spacings is 8.955.

It is a rather interesting fact that in the above solid solutions the lattice is always stretched somewhat less than would be expected from a proportional increase in lattice size computed from atomic volume considerations. This indicates a weak but perfectly definite attraction between unlike atoms. For example, the tin atom is 186 per cent larger than the copper atom, but 5 per cent of tin atoms in copper does not increase the average cube $186 \times 0.05 = 9.3$ per cent (the proportional increase), but by only 4.6 per cent. Again, the zinc atom is 29.5 per cent larger than the copper atom, but 30 per cent of zinc atoms does not increase the lattice size by 8.87 per cent (the proportional increase), but by only 6.8 per cent. It is also apparent that the tin and copper atoms pack more closely—considering the volume of the tin atom—than do zinc and copper.

Copper-Aluminum

A 91:9 Cu:Al alloy has an atomic ratio of 81.2 Cu to 18.8 Al. Incorporation of that amount of aluminum stretches the lattice 0.91 per cent, equivalent to a volume change of 2.8 per cent. The cube edge becomes 3.633 A.u. as compared to the 3.60 for pure copper. Copper and aluminum show a strong attraction in the alpha solution, for we should expect an increase of 7.52 per cent in volume from the substitution of aluminum in 18.8 per cent of the copper lattice points, since the aluminum atom is about 41.0 per cent larger than the copper atom.

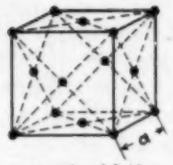
Copper-Manganese

Copper-manganese alloys are often represented as an example of the completely miscible isomorphous series, but X-ray examination has shown that some ranges of composition reveal the simultaneous presence of both the lattice type of copper and the lattice type of manganese in a thoroughly annealed specimen. So there is apparently a limit for solubility of manganese in the copper lattice. A normal copper lattice is extended very slightly by the substitution of manganese atoms. When one out of three copper atoms has been replaced by manganese the original cube edge of 3.60 has become 3.615 A.u. Further additions of manganese seem to be rather more effective in stretching the lattice,

[6] "X-Ray Analysis of Three Series of Alloys," Mary R. Andrews, *Phys. Rev.* (1921), vol. 18, p. 245.

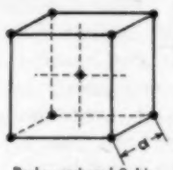
Face-Centered Cubic

	a		a
Al	4.05	Pd	3.950
Ca	5.56	Ag	4.060
Fe(γ)	3.60	Ce	5.12
Co	3.554	Ir	3.805
Ni	3.540	Pt	3.930
Cu	3.60	Au	4.08
Rh	3.820	Pb	4.92
		Th	5.04



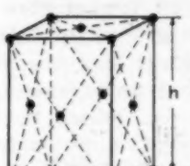
Body-Centered Cubic

	a		a
Li	3.50	Fe (α)	2.86
Na	4.30	Mo	3.143
V	3.04	Ta	3.272
Cr	2.895	W	3.150



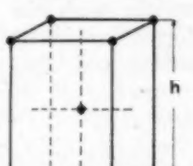
Face-Centered Tetragonal

	a	c
Indium	4.58	1.06



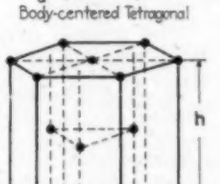
Body-Centered Tetragonal

Tin (while the atoms of tin are not arranged exactly as indicated, the lattice appears to consist of two interpenetrating simple tetragonal lattices).
$a = 4.00$. $c = 0.94$.



Hexagonal Close-Packed

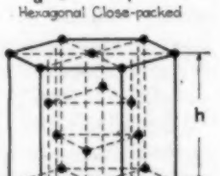
	a	c
Mg	3.22	1.624
Ti	2.97	1.59
Co	2.514	1.633
Zn	2.67	1.86
Zr	3.23	1.59
Ru	2.686	1.59
Cd	2.960	1.89
Ce	3.65	1.62
Os	2.714	1.59



Rhombohedral

	a	c
Antimony	4.280	2.647
Bismuth	4.54	..

The author found the lattice as shown, but every exact work by James and Tunstall, *Phil Mag.*, vol. 40, p. 233, reveals the fact that half the atoms are very slightly displaced from the position indicated.



Hexagonal

Graphite ..... $a = 2.47$ $c = 2.75$
Alternate planes have large and small spacings with ratio 6:1.

Tetrahedral Cubic

Tetrahedral cubic has isometric symmetry, but for comparison it may also be shown on a hexagonal lattice in which the vertical axis is the trigonal axis of the cube. Actually the arrangement consists of two interpenetrating face-centered lattices somewhat removed from the position resulting in the simple cubic arrangement. The horizontal planes have large and small spacings of 3:1.

	a	c
Diamond	2.52	2.449
Silicon	3.84	2.449
Tin (gray)	4.57	2.449

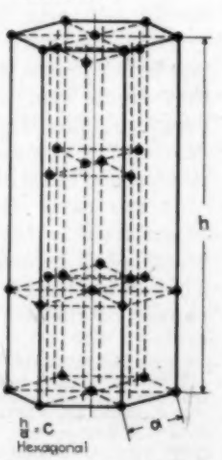


FIG. 2—CRYSTAL STRUCTURE OF SOME METALS AND THEIR ATOMIC SPACING

although the change is so small it is difficult to be sure of this fact.

Manganese lattice has not yet been completely deciphered. It has an atomic volume of 7.4, while copper is 7.1. Manganese much more nearly distends the copper space lattice in proportion to its atomic volume than most other atoms; the absolute amount, however, is small, since their atomic volumes are so similar.

Silver-Cadmium

If we saturate solid silver with cadmium, we increase the cube edge about 1.1 per cent (a volume change of about 3.5 per cent). This is notably less than the proportional increase due to disparity in atomic volume, as cadmium has an atomic volume 27.4 per cent greater than silver.

Silver-Zinc

Silver saturated with zinc in the solid decreases the cube edge from 4.06 to 4.005 A.u., a shrinkage of 1.36 per cent, or a volume change of 4.0 per cent. Zinc has an atomic volume only 9.8 per cent less than silver, and this is greater shrinkage than would be expected from the difference in atomic volume. This behavior of the two silver alloys strengthen the idea that there is a mutual attraction between unlike atoms, causing them to pack closer than their separate atomic volumes would warrant.

Iron-Chromium

In iron and chromium we have two metals chemically similar and with atomic arrangement identical in type and differing very little in atomic spacing. We should expect great mutual solubility. As a matter of fact, the alloys resulting from fairly rapid cooling from the melt seem to be all true solid solutions regardless of composition, but there is some reason to believe a very prolonged heating at about 1,100 deg. C. develops a new constituent. It is therefore doubtful if the system comprises a continuous series of solid solutions. There is no measurable change in the lattice. The spacings of iron and chromium (2.86 and 2.895 A.u.) are so nearly alike that great accuracy would be required to detect any stretching or shrinking. Very little would be expected.

Tungsten-Iron and Molybdenum-Iron

These two series, composed of body-centered cubic metals, might be expected to form continuous isomorphous alloys, but both tungsten and molybdenum form the 1:1 compounds WFe and MoFe of a hexagonal type not fully elucidated. Solid iron dissolves a few atomic per cent of both W and Mo, but, strange to say, the space lattice is not measurably altered. The atomic volume of tungsten and of molybdenum is about 10, as compared to 7.1 for iron. The explanation may be that there is an inordinate attraction between these atoms, chemical in nature, which results in the preservation of the smaller iron spacing even in a solid solution. From X-ray examination it appears that very little if any iron can be dissolved in tungsten or molybdenum without the formation of the compound.

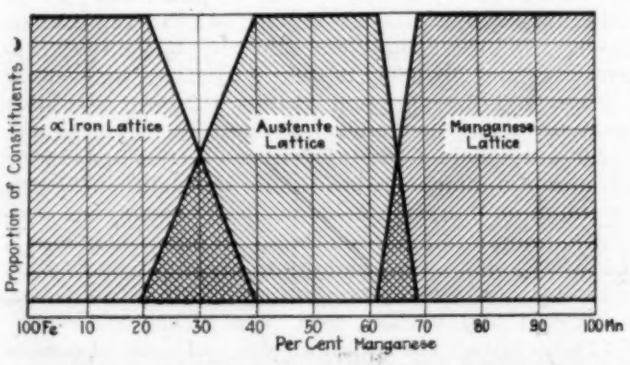


FIG. 3—PROBABLE STRUCTURAL RANGES FOR ANNEALED ALLOYS OF IRON AND MANGANESE

Iron-Manganese

Both Gulliver[7] and Desch,[8] quoting Tammann, present the iron-manganese series as an example of complete miscibility in the solid. X-ray diffraction patterns of the series show that three crystal entities in all are present in the system. Fig. 3 shows diagrammatically the regions of each lattice and their overlapping ranges. The alloys examined were cooled very slowly and the data are representative of conditions approaching equilibrium at room temperature. Body-centered ferrite lattice is preserved until about 30 per cent of its points have manganese atoms substituted for the iron. Further additions of manganese develop the face-centered cubic lattice of gamma iron (austenite) and the alloys appear to be wholly of this structure up to about 60 per cent manganese; beyond this point we have the manganese structure appearing, doubtless with iron atoms occupying lattice points in the manganese space-lattice. The purest manganese obtainable has a very complex structure and it has not yet been worked out. It is the author's opinion that if very pure manganese is prepared it may have the body-centered cubic lattice of iron, because X-ray spectrograms made from some manganese-rich alloys produced very definite lines of a body-centered cubic pattern. It may be that the presence of some iron causes the manganese to overcome the action of some slight impurity such as silicon or aluminum, or some other element which induces the complex structure usually found.

Solid Miscibility in All Proportions

It is self-evident that only those elements having the same crystalline type could form a continuous series of solid solutions. If metal *A* and metal *B* are of different lattice types and possess great mutual solubility, we must still find solid solutions of both *A* in *B* and of *B* in *A*. It seems likely that in some ranges of composition these two solutions may exist simultaneously and even have the same composition, the relative amounts of each varying with temperature.

This is certainly the case in the nickel-iron series. Thoroughly annealed specimens are body-centered near the iron end of the series and face-centered in the nickel-rich alloys. Over a great range of intermediate compositions both atomic arrangements are present, the relative amounts depending upon the heat-treatment. Of course, the circumstances are complicated by the allotropy of iron. Early in 1921 the author showed for the first time the allotropic change in iron from body-centered to face-centered atomic arrangement with rise in temperature above 900 deg. C. Following this discovery it was easy to see how the presence of a number of atoms of nickel (whose normal arrangement is that of face-centered gamma iron) can inhibit the transformation to alpha iron, which is body-centered. Why

[7] "Metallic Alloys," G. H. Gulliver, 4th edition, 1921, p. 332.
[8] "Metallography," C. H. Desch, 2nd edition, 1913, p. 401.

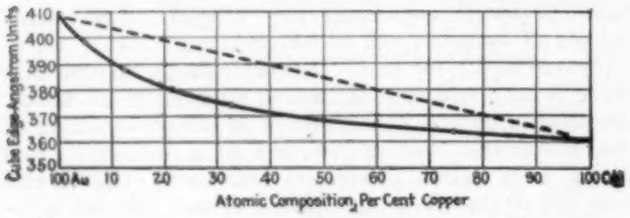


FIG. 4—SIZE OF FUNDAMENTAL CUBE IN THE COPPER-GOLD SOLID SOLUTION SERIES

manganese acts in the same way is not so obvious. The effect of heat-treatment on the relative proportions of the two kinds of solid solutions present in a continuous series is not so marked in the copper-manganese alloys, for instance, as is observed in manganese-iron and nickel-chromium alloys.

It appears that the main reason for classifying these series as continuous solid solutions is the fact that thermal analysis indicates a smooth continuous solidus

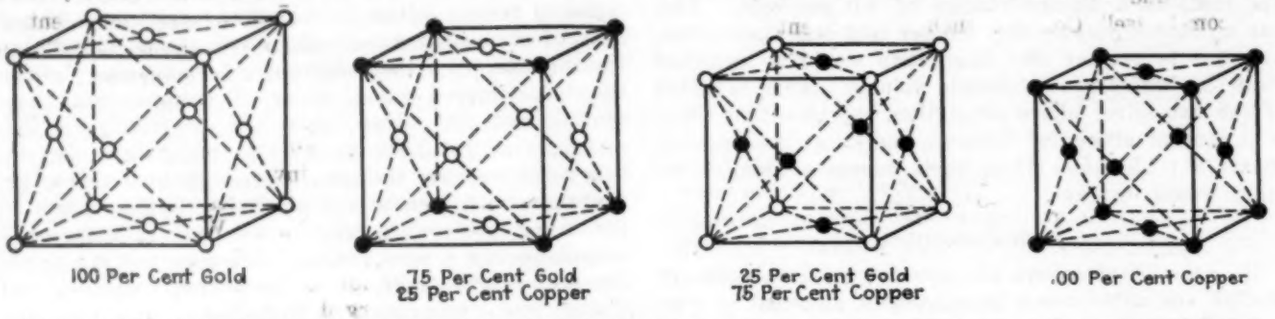


FIG. 5—ARRANGEMENT OF THE GOLD (LIGHT CIRCLES) ATOMS IN SPACE FOR CERTAIN GOLD-COPPER ALLOYS

or liquidus line. If the solubility of *A* in *B* cannot quite reach the composition of saturated *B* in *A*, the evidence for a region of incomplete miscibility is clear enough, but in some alloy systems they appear to overlap. This leads to an erroneous classification. In the latter group may be put cobalt-iron, iron-manganese, indium-lead, cobalt-chromium, chromium-nickel, copper-manganese, manganese-nickel and iron-nickel. It is likely that a suitable etching reagent on well-annealed specimens would reveal two distinct phases under the microscope. Meteoric iron shows two iron-nickel constituents.

But there are quite a large number of truly continuous solid solution series, exemplified by copper-gold, copper-nickel and gold-silver. Several have been studied with X-ray diffraction and are described here. Not all pairs of elements of the same atomic structure form such series of alloys, for many build intermetallic compounds.

Copper-Nickel

The lattice change in these alloys is small but continuous. The contraction due to unlike atoms is so very small as to be immeasurable by the apparatus at present in use. The alloy has already been described from the atomic arrangement standpoint.[4]

Copper-Gold

The series remains perfectly face-centered cubic in structure throughout. The lattice size or spacing changes gradually from copper to pure gold, the cube edge ranging between 3.60 to 4.08 A.u. But this stretching of the copper lattice by substitution of gold atoms is not proportional to the number of gold atoms present. Fig. 4 shows that the alloy is more dense (closer spaced) than the lineal function would demand. It again appears that the unlike atoms attract one another more closely than like ones. Fig. 5 represents the crystalline arrangement of two of the intermediate alloys in comparison with the pure components.

Gold-Silver

Gold and silver have very nearly the same atomic spacing. The whole series has the same spatial arrangement, varying from 4.06 to 4.08 A.u. on the cube edge. There is no measurable departure from the lineal relation between atomic proportion and lattice size.

Molybdenum-Tungsten

This series presents the same aspects as the gold-silver series except that it is of the body-centered cubic type. The cube edge varies continuouslly with composition from 3.143 to 3.150 A.u. Here again we find no measurable attraction of unlike atoms to cause any unexpected lattice size. The inference is that this effect is dependent upon the disparity in atomic volume. That is to say, when large and small atoms are packed in a common lattice, they are drawn more closely than their respective sizes and proportions would indicate, while unlike atoms of about the same size do not show attraction and compression to any extent.

German Chemical Exports to America

Preliminary returns of Germany's foreign trade in chemicals during the first 9 months of 1922 are given in *Commerce Reports* for Dec. 25, 1922.

The United States purchases of these chemicals for the 9 months included (all quantities in kilos): Alkali metals, etc., 75,800 kilos; white and red phosphorus, 191,300; lactic acid and lactates, 165,600; tartaric acid, 716,100; citric acid, 42,500; crude potash salts, 97,755,000; fertilizer salts, 119,456,900; barium chloride, 285,300; bromides and bromoform, 516,800; ammonium carbonate, 262,600; caustic potash, 4,029,100; pot ashes, 2,087,700; chloride of lime, etc., 3,221,400; potassium chlorate, 1,570,600; sodium sulphate and bisulphate, 5,767,100; potassium sulphate, 45,436,700; copper sulphate, 161,200; alums, 1,576,300; ammonium nitrate, 4,817,700; barium nitrate, 107,800; potassium manganate and permanganate, 228,800; ferricyanides, 114,900; cyanides, 64,300; tartar and tartrates, 443,000; carbonate of strontium, etc., 1,800; zinc salts, 1,029,200; arsenous and arsenic acid, 402,900; magnesium sulphate, 8,303,900; chlorides (calcium, magnesia), 4,448,000; muriate of potash, 102,975,600; ammonium chloride, 1,784,700; potassium and sodium sulphates, 1,062,100; and barium, lead, and nickel compounds, 9,149,800 kilos. The American share of other chemicals exported is not shown in the preliminary official statistics.

Legal Notes

BY WELLINGTON GUSTIN

Public Interest in Every Adjudication Regarding Validity of Patents Emphasized

In a suit brought by the Griscom-Russell Co. against the Standard Water Systems Co. and others, a decree of the United States District Court for the complainant has been reversed by the Circuit Court of Appeals, and claim 8 of patent 1,131,738 for an evaporator was held void for lack of invention, in view of the prior art. (278 Fed., 703.)

The Griscom-Russell Co. charged defendants with infringement of its patent, issued to Reuben R. Row, one of the defendants. The bill charges that the inventor and two other defendants employed by the Griscom-Russell Co. left such employment and associated themselves with the Standard company, with the purpose and intent to injure the Griscom company, by appropriating to themselves and the Standard company valuable data, engineering designs, drawings, etc., which were the property of the Griscom company and that they all conspired together to infringe the letters patent.

The District Court decreed the Griscom company to be the lawful owner of the patent and that the defendants had jointly infringed the patent and that the plaintiff recover profits, gains and advantages; and that an account be stated. An injunction was issued against the defendant company only.

On appeal the Circuit Court of Appeals found no direct testimony of any federation between the individual defendants for the purpose of injuring the plaintiff.

INVENTOR MAY SHOW LIMITATIONS BY PRIOR ART

What seemed to weigh most heavily against the defendants, says the court, in this case is the fact that one of them asserted invention to procure a patent which he assigned to the plaintiff, and that, while all of the individual defendants were subsequently associated with their co-defendant, the said co-defendant manufactured and sold devices with the patented improvements embodied therein.

One who asserts and claims an invention and receives a patent therefor is estopped from denying invention, but the court says he is not estopped from showing to what extent his alleged invention is limited by the prior art.

The public is interested in every adjudication with respect to the validity of a patent, and it is the duty of courts having jurisdiction of patent causes to have regard, at all times, of the rights of the public, so that such rights may be rather enlarged than diminished by judicial determination. The public interest in every patent is set out in the case of Hill vs. Wooster, 132 U. S., 693. That opinion emphasizes the doctrine that it is not enough that the thing shall be new, that in the shape or form in which it is produced it shall not have been known before, and that it shall be useful; but it must, under the Constitution and the statutes, amount to invention or discovery. (Hansen vs. Slick, 145 C.C.A., 37.)

Returning to the case at bar, the court says the process of vaporizing water or other liquid to obtain a purer liquid is old. And the apparatus for accomplishing the result desired is old. The claim of the patent is as follows:

"The improvement in evaporating apparatus for obtaining purified liquid, which comprises a containing shell, a door closing an aperture in said shell, a heating pipe structure secured to said door and projecting within said shell, a supporting roller for said structure outside said shell, substantially as described."

The court was of the opinion that there was no invention in the addition of rollers to the evaporator. It says: "The addition of rollers to a desk, in order that it may be moved, so that the carpet could be cleaned under it, was an improvement by the man who added the rollers; but that invention did not add to the dignity of invention or discovery, within the meaning of the Constitution and the laws passed in pursuance thereof, intended to give an inventor an exclusive right for a time, as against the public."

Regardless of the rule that a patentee or an assignee of a patent cannot deny invention, it is the duty of the court to determine lack of invention, where apparent, in order that the public interests may be guarded. Therefore the decree of the lower court was reversed.

Interstate Shipment Is Protected From State Law Until Sale of Original Packages

An interesting point is involved in injunctive proceedings begun in the United States District Court by the Cleveland Refining Co. against W. H. Phipps, director, attacking the constitutionality of an Ohio statute providing for inspection of petroleum products and fixing fees to be charged therefor. The court says that a state has power to enact proper inspection laws and provide for the collection of the necessary expense of inspection and is not required to fix with exactness the fees which will cover such expense, but as applied to articles of interstate commerce the fees must reasonably approximate such cost and not be so excessive as to render the law a revenue measure.

Plaintiff is engaged in the sale and distribution of kerosene, petroleum and their products. It buys in other states, ships into Ohio large quantities of such articles in storage tanks, barrels, cans and packages, and has contracts for such articles which it is bound to consummate.

Plaintiff contended that the inspection fees were excessive, that they interfere with interstate commerce and are an unlawful import duty upon goods shipped into Ohio from other states and as such the law violates the sections 8 and 10 of Article I of the U. S. Constitution. And so the District Court held. The court found the fees charged for inspection were yearly increased until they doubled the cost, and that there was no distinction made between oil produced in the state and that brought in from other states.

The court says that where goods are transported into one state from another in original packages, interstate commerce therein is not completely terminated, and they are protected by the commerce clause of the Constitution against excessive inspection, until after their sale at the point of destination within the state.

Now the fees prescribed by the statute were beyond the cost of legitimate inspection to determine the quality of the articles inspected, and the act is therefore not only a police measure but a revenue measure also. Such cost by necessary operation unduly burdens and obstructs the freedom of interstate commerce and as such commerce cannot be separated from the interstate shipments, the whole tax is void.

Vapor Recompression Systems for Evaporators—I

An Unprejudiced Survey of the Advantages and Shortcomings of Regenerative Evaporation — A Technical History of Its Development and an Analysis of Recorded Data on Test Runs*

By W. L. Badger
Professor of Chemical Engineering, University of Michigan

IMAGINE a simple evaporating device, with liquid boiling in it at atmospheric pressure. Also assume that it is heated by steam at 10 lb. gage (240 deg. F.), that no heat is lost in heating feed, in radiation or in any thick liquor drawn off, and that the condensate leaves at the temperature of the boiling liquid. To evaporate 1 lb. of water will take 970.4 B.t.u., and 1 lb. of steam will give up 980.4 B.t.u. A very slight change in our fundamental assumptions will make the two exactly equal. Then, what is happening really comes down to converting 1 lb. of steam at 240 deg. and 10 lb. gage to 1 lb. of steam at 212 deg. and atmospheric pressure.

Now if the hot condensed water is returned to the boiler without loss, we will have to add 980.4 B.t.u. to regenerate a pound of heating steam. But the pound of atmospheric vapor formed contains 970.4 B.t.u. more than the condensate. Why not, then, merely add 10 B.t.u. by compressing the steam instead of 980 to raise more steam? By this line of reasoning many times as much evaporation could be obtained per pound of coal burned than by raising steam direct, even after allowing for all kinds of losses.

Much has been written on this subject, but the articles have usually had a partisan bias. It is the purpose of this paper to give as nearly as possible an unprejudiced survey, and show the faults as well as the advantages of the system.

Historical and Descriptive

The first record of vapor recompression is a patent[1] by Pelletan in 1840 (36).† His apparatus is shown in Fig. 1. A pan *m* has a cover *T* supported by counterweights. Heating is done by two coils *g*. High-pressure steam is admitted by *E* and *F* to the injector nozzles *B*. These draw vapors from the pan through pipes *a* and compress them in the coils. This apparatus was unsuccessful, partly due to faulty nozzle design and partly to the very low boiler pressures then carried.

The Piccard-Weibel System

In 1874 Koerting (25) suggested the use of steam-jet nozzles for drawing non-condensed vapors from the steam spaces of evaporators, and mentioned that these vapors together with the steam which operated the nozzle would be compressed enough to be returned to the steam space (28). Nothing was done, however, till the advent of the Piccard-Weibel system in 1879 (30). It received considerable notice through the '80s (6, 11, 15, 26, 27, 40, 43, 44). Fig. 2 shows the system applied to a single effect evaporator. The reciprocating compressor *C* takes vapor from the dome *A* and compresses it to be used in the steam space. This figure shows how early it was realized that in such installations all possible heat must be saved, for the heat interchanger *S* is provided to heat the feed by the heat of the condensate. If the compressor *C* were to be steam driven, the exhaust was best utilized in a triple-effect as shown in Fig. 3.

This system was employed in several salt plants in France and Austria, and in a few sugar mills. It was installed in the mill at Pohrlitz in 1882. Weibel (43) reports that the mill of 225 tons per 24 hours sent about one-third of the juice to the thermocompressor evaporator. This was a triple of 150, 60 and 80 sq.m. respectively (vertical tubes). The compressor was 31.5x19.5 in. (fifty strokes per minute), took steam at 59 lb. gage and exhausted at 6 lb. gage. It took vapor at atmospheric pressure from the first effect and compressed it to 6 lb. One lb. of boiler steam theoretically should have compressed 2.5 lb. vapor and furnished 1 lb. of exhaust, which would have evaporated 3 lb. in the triple effect, making a total of 5.5 lb. evaporated per pound steam. A very complete test was later made on this system (31, 42) which showed actually 4.4 lb. of water evaporated per pound of steam. While the Piccard-Weibel system was retained for a considerable time in salt works which had ample water power, it never gained a foothold in the sugar industry because of the excessive size and, at that time, rather poor design (11) of the reciprocating compressors needed.

The Nozzle Compressor

In the later developments, two lines of work have been followed—the nozzle compressor and the turbo-blower. Along the line of nozzle developments the principal place is held by Prache and Bouillon, who in 1905 developed a steam jet nozzle (102), such as is shown in Fig. 4, and which was claimed to be far superior to any other. The nozzle alone cannot make a practical device, and an explanation which anticipates the theory must therefore be introduced.

In order to obtain a satisfactory capacity of the nozzle, the pressure range through which the vapor is compressed must be small. Neglecting minor factors, this pressure range is made up of two parts: (*a*) The

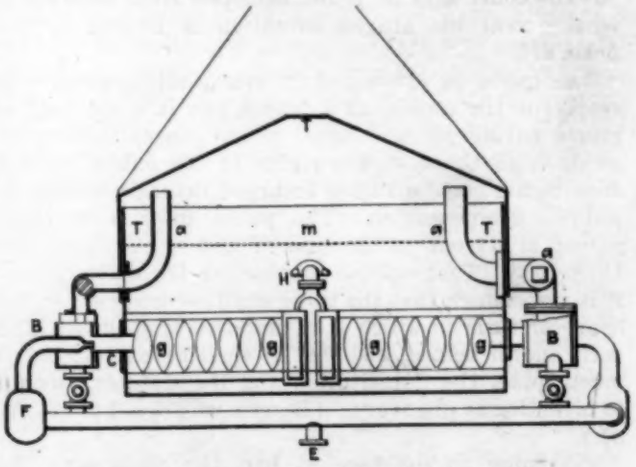


FIG. 1—VAPOR RECOMPRESSION APPARATUS OF PELLETAN

*Read before the American Institute of Chemical Engineers at Baltimore, Dec. 9, 1921.

[1]In (12) this date is given as 1834.

†Numbers in parentheses refer to bibliography to be published at end of Part II. Numbers below 100 are articles and above 100 are patents.

Chem. & Met., Jan. 3, 1923.

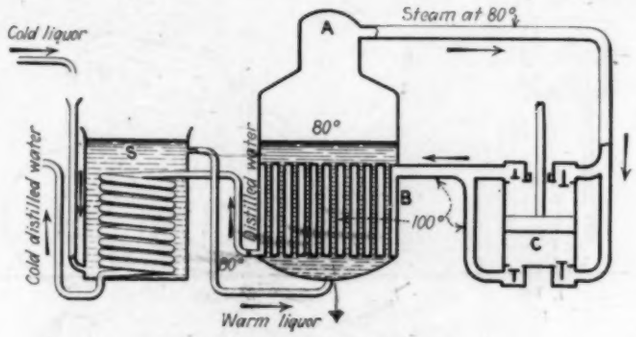


FIG. 2—PICCARD-WEIBEL SYSTEM

elevation in boiling point of the solution, (*b*) the working temperature drop. The first part cannot be changed, but its effect may be minimized by confining the concentrated liquid to one part of the apparatus; for when an ordinary evaporator works continuously, the whole body is full of liquid at the final concentration. The second factor is, of course, within the control of the designer; but the smaller it becomes the larger must the apparatus be for a given performance. If an evaporator could be designed with an unusually high coefficient of heat transmission, an evaporator for a given duty could operate on a smaller temperature drop than usual without increase in size. Hence the features to be noticed in the recent developments are (1) isolation of the more concentrated parts of the solution, and (2) attempts to increase the heat transmission coefficient.

Prache and Bouillon (or as later organized, La Société d'exploitation de procédés evaporatoires système Prache et Bouillon) first developed the evaporator shown in Fig. 5 (4, 5, 36, 101, 114, 123, 133). Here the liquor space of an ordinary vertical tube evaporator is divided by partitions, *P*, which extend some distance above the upper tube sheet and also completely divide the liquor space below the tube sheet. Each compartment has its own downtake *n*, and in the center of each downtake is a pipe *O* leading to the next compartment. Thus a part of the liquid is continually being passed from compartment to compartment, being finally withdrawn from 7. In this way the solution of highest boiling point is localized in the last compartment and only a part of the heating surface is handicapped by this loss in temperature drop.

The steam space is not divided. Therefore, if the vapors are compressed enough to give the desired working temperature drop for the dilute liquor, the compartments containing concentrated liquor will have a smaller temperature drop. But it is just these compartments which need a larger working drop than the others, because of the effect of their increased viscosity and density on heat transfer. If, on the other hand, the vapor is compressed sufficiently to give a satisfactory working temperature drop for the last compartment, it will result in a range of compression too great to be economical for the others.

A Horizontal Tube Evaporator

Prache and Bouillon later devised another evaporator which was to minimize the effect of boiling point and also increase the heat transfer coefficient. Fig. 6 (4, 38, 134) shows this evaporator, consisting of several compartments side by side, each containing inclined tubes with liquor inside, and arranged in series as to liquor feed. All the compartments discharge into a common header, which is, however, provided with partitions to keep the liquor from each compartment separate from the others. A wide tube *E* for recirculation is provided at the bottom, and means (not shown) are also provided for transferring the liquid from compartment to compartment. Cold feed from *A* first passes through the preheater *B*, then by pipe *C* to the evaporator, circulating through each compartment and finally leaving at *F*. Vapors from all the compartments collect in *I*, are compressed by boiler steam in the nozzle *H*, and go from compartment to compartment in pipes *K*. Here evidently the amount of compression for all the vapors is sufficient to overcome the elevation in boiling point in the last compartment.

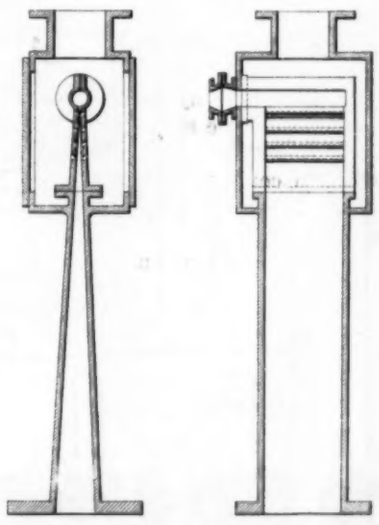


FIG. 4—PRACHE AND BOUILLON NOZZLE

Since the compression is done by a steam jet, there is a continual supply of steam to the apparatus above that which can be condensed by evaporation. Hence

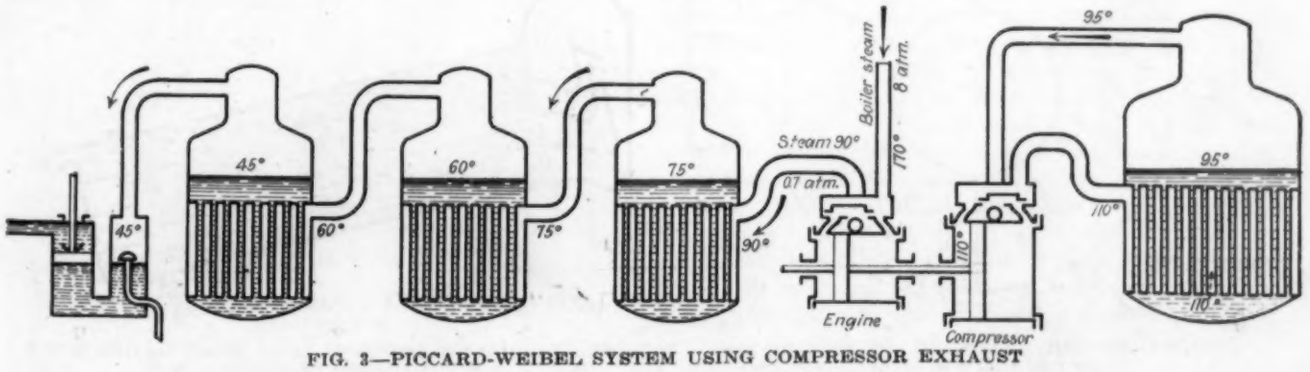


FIG. 3—PICCARD-WEIBEL SYSTEM USING COMPRESSOR EXHAUST

there is a pipe from the steam chamber *I* to the preheater *B*, and from there to an exhaust or to a condenser. The apparatus works in single effect; the compartments differ only in the concentration of the liquid in them, and there will be little drop in pressure along the pipes *K* leading steam from compartment to compartment. The statement is made (4) that the heat transmission coefficients obtained in this evaporator are about double those of an ordinary evaporator. The same writer states that at that time (1916) about seventy-five Prache and Bouillon plants were in operation.

A similar evaporator patented by these workers has the compartments superimposed in one common shell. Fig. 7 (104, 117, 139, 144).

Recently a nozzle as applied to evaporators has been developed by de Baufre at Annapolis (13, 39, 107, 109, 110, 111, 145), and is shown in Fig. 8. In ordinary operation, high pressure steam is expanded through the orifice *B* and nozzle tube *C*. Vapor from the evaporator is drawn in through the inlet, and the mixture of

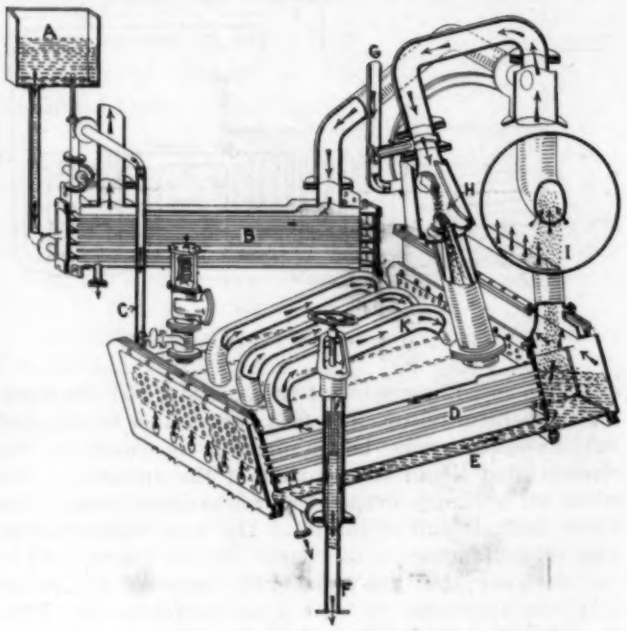


FIG. 6—PRACHE AND BOUILLON HORIZONTAL TUBE EVAPORATOR

compressed vapor and expanded high-pressure steam is discharged through *K* to the evaporator coils.

Nozzle Performance and Design

The performance of nozzles has been studied and some results reported. Eslancher (17) has reported data on the Prache and Bouillon nozzle which have been copied several times (55, 38). From these data Fig. 9 has been drawn. This shows the ratio of (pounds vapor) to (pounds high-pressure steam) for different steam pressures, vapor temperatures and temperature drops. By temperature drop is here meant the difference between the temperature of the steam in the heating space and the temperature of the boiling liquid. It will be noticed that the capacity of a nozzle falls off rapidly as the working temperature drop increases and as the pressure range through which the high-pressure steam is expanded decreases. It is obvious why the working temperature drop for such systems must be held below 10 deg. C.

De Baufre's nozzle has also been tested (13, 39). The data are represented in Fig. 10. The curve for nozzle tip No. 2 is reproduced as Curve 2 in Fig. 11. Curve 1, Fig. 11, is obtained from Fig. 9 for 175 lb. steam (the conditions under which de Baufre's nozzle

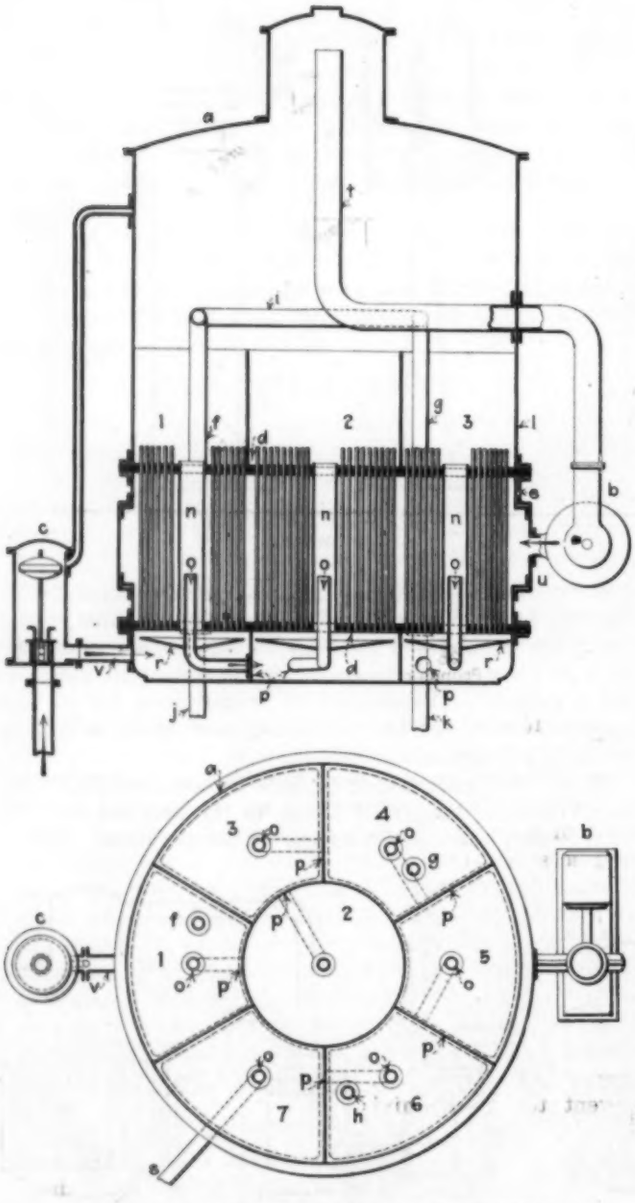


FIG. 5—PRACHE AND BOUILLON VERTICAL TUBE EVAPORATOR

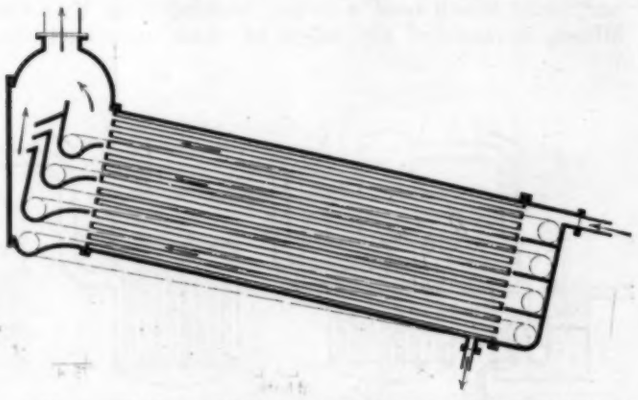


FIG. 7—PRACHE AND BOULLION EVAPORATOR WITH SUPERIMPOSED COMPARTMENTS

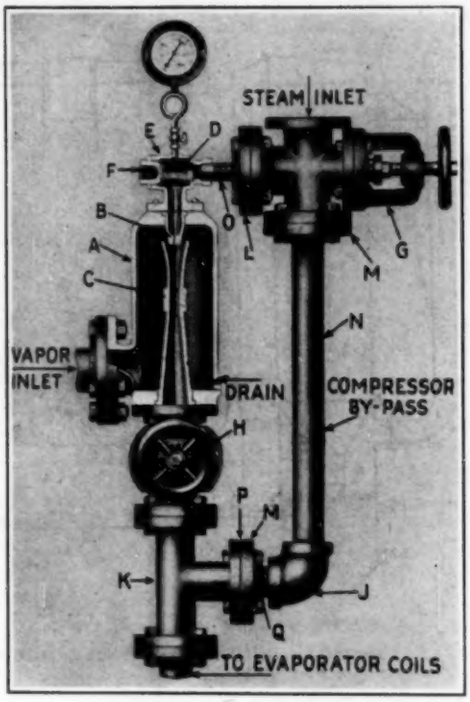


FIG. 8—THE DE BAUFRE NOZZLE

is tested). There have been a number of patents involving the use of nozzles about which there is little or no information available (112, 120, 121, 125, 131, 138, 147, 139).

Turbo-Blower Developments

The other direction in which developments have been made is in the use of a turbo-blower. This has been universally used instead of a reciprocating compressor, in spite of its lower mechanical efficiency, because it can be built in large capacities without excessive size, and because it gives a compressed steam free from oil. The combination of a turbo-blower and an evaporator

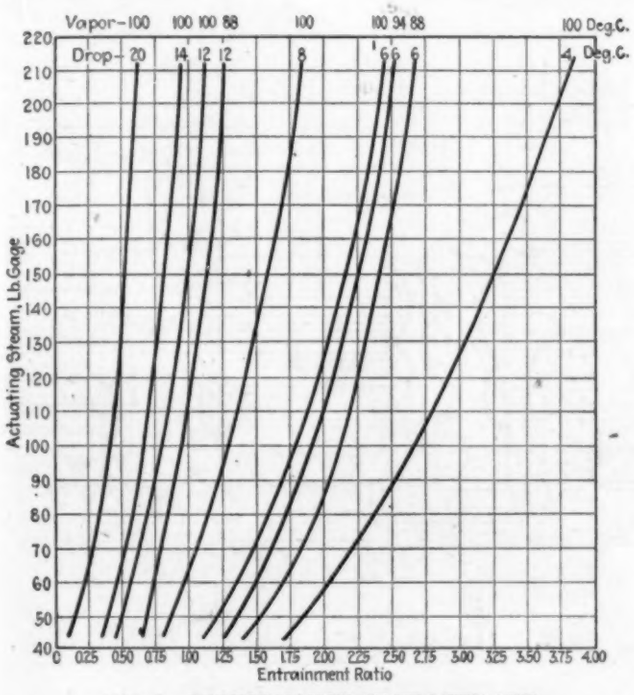


FIG. 9—PERFORMANCE OF PRACHE AND BOUILLON NOZZLE

has been given various proprietary names, such as "auto evaporator," "heat pump," etc. They are rather popular at present especially in Germany. (See 12, 16, 21, 38, 45.)

A well-known series of patents are those taken out by Soderlund and Boberg and assigned to the Techno-Chemical Laboratories, Ltd. (London) (2, 37, 105, 106, 108, 127, 128, 137, 141, 142). They have attempted both to isolate the effect of elevation of boiling point and to get a higher coefficient. This latter has been accomplished in their patents by imitating film evaporators of one type or another. For instance, in the evaporator shown in Fig. 12 (37 and 108), a high coefficient is supposed to result from liquor trickling down the sides of the tubes, distribution being through the device *i* (shown in the insert) hung in the tops of the tubes. Feed enters the heat interchanger (being preheated by condensate entering at *d*), and goes to chamber 2, is circulated by pump 4 to chamber *h*. Vapors are withdrawn from *k*, compressed by the blower 5, and returned to *m*. In Fig. 13 (106, 128, 137) high coefficients are obtained by showering the

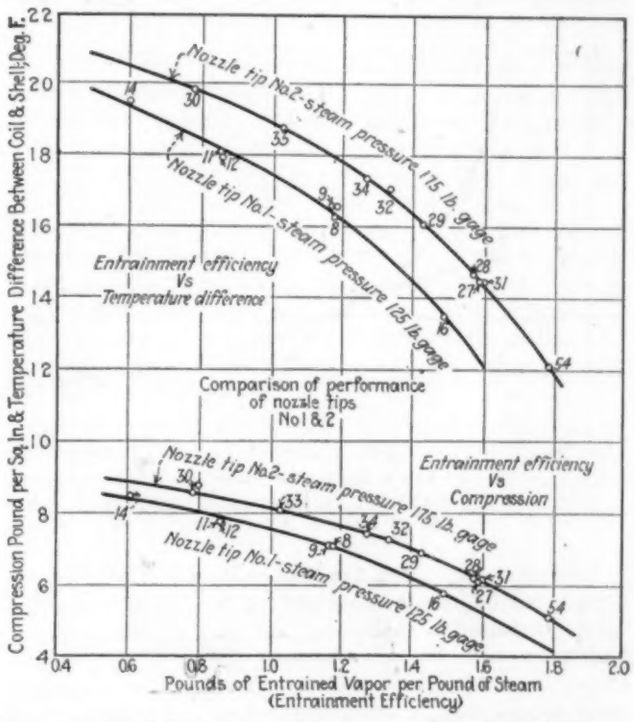

Nozzle tip No.2- steam pressure 175 lb. gage
Nozzle tip No.1- steam pressure 125 lb. gage
Entrainment efficiency Vs Temperature difference
Comparison of performance of nozzle tips No1 & 2
Entrainment efficiency Vs Compression
Compression Pound per Sq.In. & Temperature Difference Between Coil & Shell Deg. F.
Pounds of Entrained Vapor per Pound of Steam (Entrainment Efficiency)

FIG. 10—PERFORMANCE OF DE BAUFRE NOZZLE

liquid over horizontal tubes somewhat as in the Lillie evaporator; and at the same time an isolation of the effect of elevation of boiling point is obtained by running a series of bodies, vapor being stepped up by intermediate compressors to give the proper working temperature drop in each effect. Liquid is fed at 6, preheated by condensate in 7, and fed through float valve 21 into the liquor compartment. It is circulated over the tubes by pump 22, and a part is withdrawn from the first body by pipe 31 to the suction of pump 32 on the second body. The same system is repeated as often as desired. Partitions like 35 on the first body prevent too great mixing of the concentrated liquor falling from the tubes with the thinner feed. A turbo-blower 25 takes vapors from the body and compresses them sufficiently to give a working temperature drop, and also to overcome the elevation in boiling point of the liquid being boiled. The patent claims expressly

call for a working temperature drop of not over 3 deg. C. (5.4 deg. F.). Hence some type of film evaporator must be used, otherwise hydrostatic head would use up all the available drop. Part of the vapors go to the tubes of the first body, part to compressor 29, where they are given additional compression to correspond to the increased elevation of boiling point in the second body, and so on. The patent covers the same principle applied to vertical evaporators like Fig. 11, and also cases where compression is accomplished by nozzles.

There are a number of other patents covering similar devices (113, 115, 122, 124, 132, 143, 146). In general, however, a patented or special apparatus is not necessary. A nozzle or turbo-blower may be adapted to any ordinary commercial evaporator (providing the proper precautions are taken to insure the necessary conditions for satisfactory operation). Such an installation is shown in Fig. 14. The only installations on which actual working data have ever been published are those in which there is no special feature in the construction of the evaporator itself. No information has been published to indicate that the various special and patented designs are successful or practical or necessary.

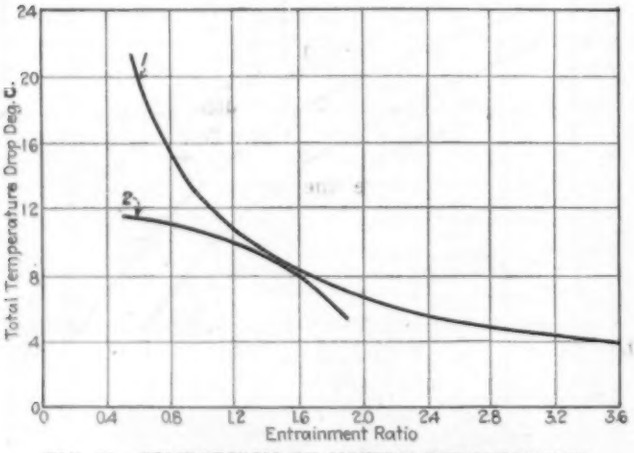


FIG. 11—COMPARISON OF NOZZLE PERFORMANCE USING STEAM AT 175 LB.

Tusschen (41) and Carlsson (8) have reported results obtained on a small installation built by A. G. Kummler and Matter, Aarau. It evaporates NaOH solution. The same evaporator is described below by Wirth (46) (Apparatus *A*). A test by Stodola of Zurich Polytechnic showed 36.2 to 37.7 lb. evaporated per kilowatt-hour. Losses, which had to be covered by the direct addition of live steam, amounted to 12.4 per cent, of which 10.7 per cent was heat lost in thick liquor. This was not recovered because the solution could be used hot in the next step of the process. During these tests the elevation of boiling point was 3.6 deg. F. at the start and 12.6 deg. F. at the end of a batch.

Ombeck (29) reports tests on an evaporator with vapor recompression. The apparatus made distilled water for ice. The evaporator is not specially described, except that it had

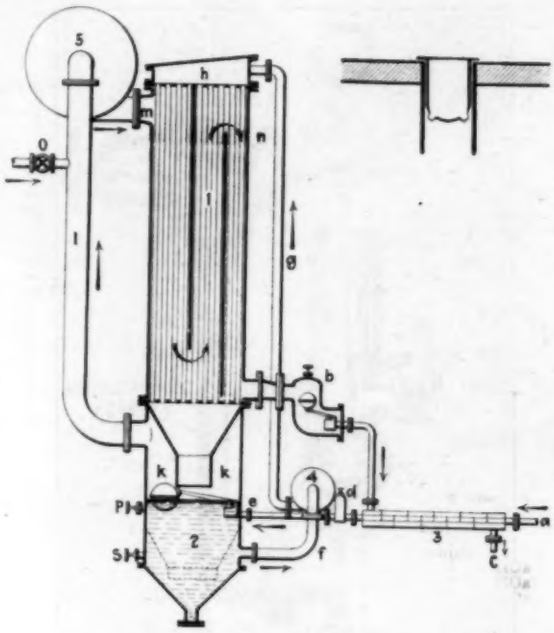


FIG. 12—VERTICAL SODERLUND AND BOBERG EVAPORATOR

1,260 sq.ft. of heating surface. Vapor was compressed with a Rateau turbo-compressor. Raw feed water was softened and then preheated in a heat interchanger using the condensate as a source of heat. The principal results, abridged and converted to English units, are shown in Table I.

Runs 8 to 10 were made immediately after installation, runs 1 to 7 after 2 months' operation, and then runs 11 to 15 after cleaning. "Compressor efficiency" is the theoretical work of adiabatic compression divided by the actual power input.

It should be noted that the efficiency of the compressor increases, but the evaporation per kilowatt-hour decreases, as the temperature drop increases. In some cases live steam had to be added to make up for losses in radiation, hot condensate, etc.; but in some cases the

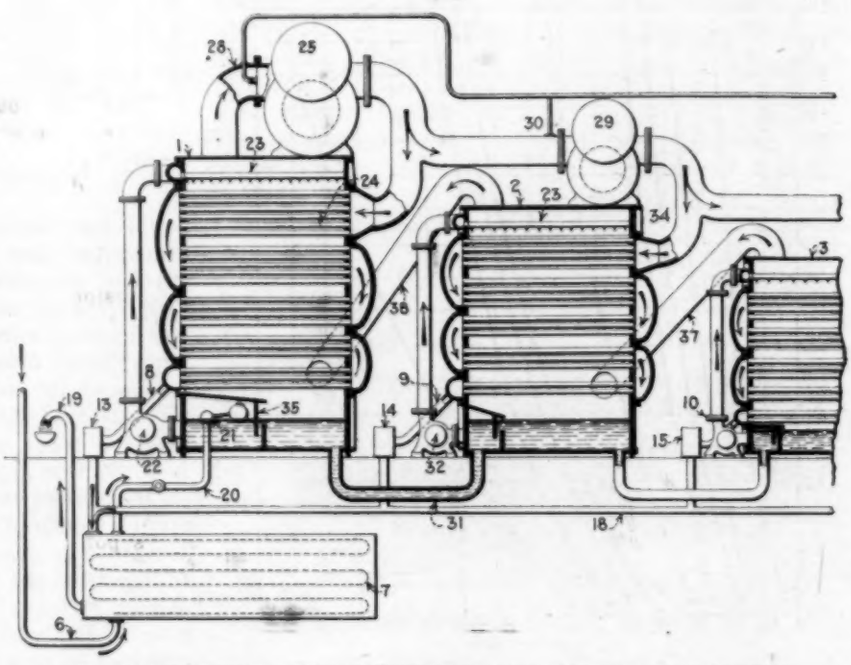


FIG. 13—MULTIPLE BODY SODERLUND AND BOBERG EVAPORATOR

TABLE I—OMBECK'S TESTS ON EVAPORATOR WITH VAPOR RECOMPRESSION

Run	Lb. Distillate Per Hr.	Vapors: Temp., Deg. F.	Vapors: Pressure, Lb. Gage	Steam: Temp. Deg. F., Calc. From Pressure	Steam: Pressure, Lb. Gage	Power Used, Kw.	Compressor Efficiency, Per Cent	Lb. Distillate Per Kw.-Hr.	Feed Temp. Deg. F.	Compressed Steam Temp. Deg. F.	Superheat, Deg. F.	Heat Added as Live Steam, B.t.u.	Apparent Temp. Drop, Deg. F.	Apparent Coefficient
1	2,120	213.5	0.45	220.0	2.51	18.22	32.2	116	210.4	225.3	5.3	55,200	6.5	246
3	3,520	213.0	0.29	222.2	3.16	32.65	41.4	108	210.1	241.7	19.5	26,700	9.2	291
5	4,420	213.1	0.32	224.3	3.96	47.07	44.8	94	210.1	251.6	27.3	2,780	11.2	301
7	4,950	212.8	0.25	226.9	4.90	64.80	45.7	76	210.0	265.9	39.0	0	14.1	269
8	5,420	212.5	0.14	222.8	3.43	42.80	55.6	126	209.7	249.7	26.6	0	10.3	388
10	6,330	213.5	0.43	225.8	4.51	55.90	55.6	113	209.8	254.5	28.7	0	12.3	439
11	3,140	213.4	0.41	219.4	2.30	19.05	42.0	165	210.4	224.1	4.7	47,600	6.0	399
13	4,410	213.3	0.38	220.5	2.65	29.05	46.3	152	210.5	233.7	13.2	27,300	7.2	451
15	5,480	213.8	0.53	222.7	3.41	41.30	50.2	133	210.6	242.4	19.7	15,000	8.9	480

TABLE II—WIRTH'S RESULTS WITH COMPRESSION EVAPORATORS

Apparatus	Material Evaporated	Concentration (In Per Cent) Initial	Concentration (In Per Cent) Final	Batch or Continuous	Heating Surface, Sq.Ft.	Elevation of Boiling Point, Deg. F. Start	Elevation of Boiling Point, Deg. F. Finish	Power Used, Kw. Start	Power Used, Kw. Finish	Lb. Evaporated Per Kw.-Hr. Start	Lb. Evaporated Per Kw.-Hr. Finish	Lb. Evaporated Per Sq.Ft. Per Hr. Start
A	NaOH	5	21	B	280	5.2	15.7	55.5	46.5	46.7	31.3	9.2
B	"Chemical Solution"	....	....	C	206	....	....	75.2	....	37.5	....	13.7
C	Sulphite Liquor	....	1.47 sp.gr.	C	3 x 475	....	....	....	....	55.2	....	23.4
D	NaOH	....	23	..	....	18	....	....	....	50.7	....	....
E	NaOH	....	31	..	384	....	41.5	....	....	25.4	....	2.87
F	NaOH	....	35	..	....	....	....	....	....	30.9	....	....

superheat from compression furnished more heat than was lost, so heat had to be discarded from the system by blowing off steam. It should also be noted that this is one of the simplest cases possible; boiling a non-scaling solution of low specific gravity and viscosity and with no elevation of boiling point.

Wirth (46)[2] has given details of a number of installations. A summary of his data will be found in Table II.

There is no special description of the evaporator construction. From the illustrations they seem to be ordinary vertical-tube evaporators with turbo-blowers.

[2]Wirth is connected with A. G. Kummler and Matter.

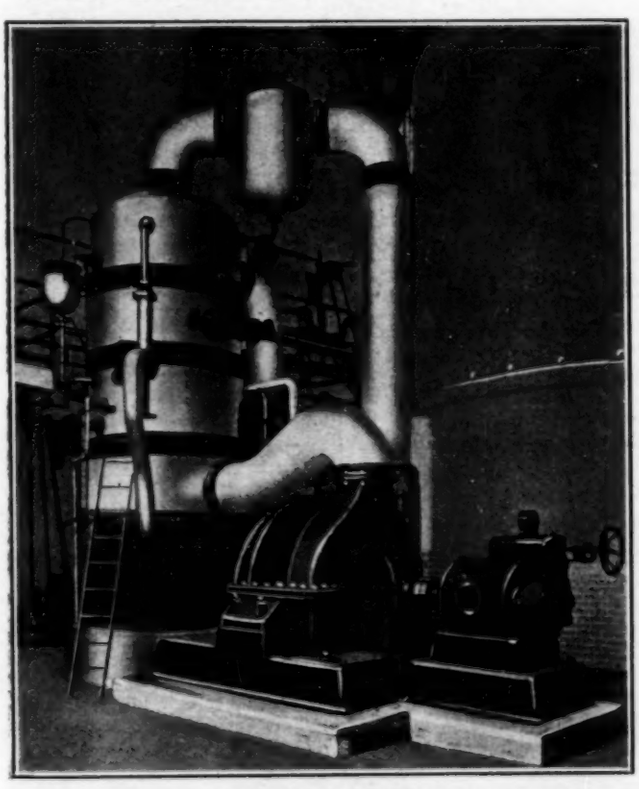


FIG. 14—VERTICAL TUBE EVAPORATOR WITH TURBO-BLOWER

Case *E* is mentioned as the lowest practical rate for thermocompressor operation. Its small rating per square foot evidently means a very small temperature drop. Evaporator *F* has three bodies, all in series as to liquor and in parallel as to vapor. The compressor is in two parts; one part takes vapors from all three and compresses to give the temperature desired for steam to the first two. It delivers some of this steam to the second part, which compresses further for the third body. Mention is also made of a milk evaporator, working with a boiling point of 50 deg. where the heat of compression more than covered the losses so that heat had to be rejected.

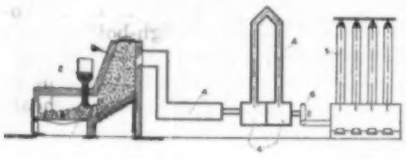
Part II of this series, which will appear in a subsequent issue, gives attention to the general theory of design and construction, together with a comparison of operating economies with single and multiple effect evaporators.

Erosion Cavities in Limestone Deposits

The limestones of the Shenandoah Valley of Virginia and West Virginia are characterized by numerous solution cavities brought about by surface or subterranean stream erosion, states the Bureau of Mines. The quarryman's difficulty is due to the occurrence, even at considerable depth, of erosion cavities, not in the form of open spaces, but filled with red clay. These clay masses are troublesome, and their removal is costly. The problem is of general interest to all limestone quarrymen, for erosion cavities are characteristic of limestone deposits, though they are not generally developed as much as in the district under consideration. Some form extensive caverns in which part of the dissolved calcium carbonate has been redeposited as stalactites and various other ornate forms. Some of the caverns have been illuminated and opened to the public as commercial enterprises. In a few instances the cavities constitute a commercial asset in the valley, yet from the quarryman's point of view they are a decided disadvantage, for they constitute one of his hardest problems. A discussion of stripping problems in limestone quarries in the Shenandoah Valley is contained in Serial 2401, by Oliver Bowles, mineral technologist, which may be obtained from the Bureau of Mines, Washington, D. C.

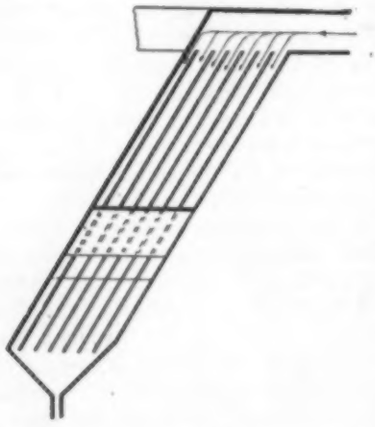
Recent Chemical & Metallurgical Patents

Production of Metallic Arsenic—J. L. Cullen, assignor to the United States Smelting and Refining Metals Co., has patented a process for producing metallic arsenic from the oxides obtained in the metal-refining plants. The present method of distilling mispickel in clay retorts is dangerous. The new method consists in passing vaporized arsenic oxides over red hot charcoal or coke.



Referring to the diagram, (1) is a furnace into which arsenic oxide is fed from a hopper (2), and after volatization it passes through tower (3) packed with hot coke. Reduction takes place and the gases are cooled in pipes (4) and collected in bags (5). A fan (6) may be used to control the flow of gases. (1,433,533. Oct. 30, 1922.)

Separation of Dust From Gases—N. C. Christensen, Salt Lake City, Utah, has patented an apparatus for settling finely divided solids and liquids out of suspension of gases. The principle upon which this apparatus is based is that settling takes place rapidly if there are no eddy currents in the gas as it is moving along a pipe or in a gas that is still. The apparatus consists then essentially of means of producing a steady flow of gas currents. The inventor also claims that once settled out the solids or liquids can flow with the gases along tubes properly inclined and not be stirred up so as



to form a suspension again. The accompanying figure shows one of the designs submitted by the author to produce a steady flow of gases through the apparatus. The inclined passageways produce both a lateral and a vertical or longitudinal counter flow, and this combination is of great importance in effecting the settling of very finely divided dust. It is claimed that this apparatus will permit the doing away with any filtration of effluent air and thus much simplify present installation. (1,434,090. Oct. 31, 1922.)

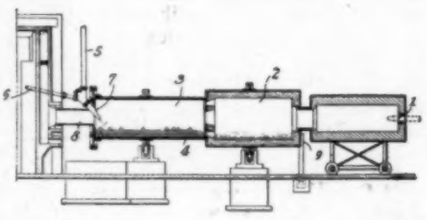
American Patents
Issued Dec. 19, 1922

The following numbers have been selected from the latest available issue of the *Official Gazette* of the United States Patent Office because they appear to have pertinent interest for *Chem. & Met.* readers. They will be studied later by *Chem. & Met.'s* staff, and those which, in our judgment, are most worthy will be published in abstract. It is recognized that we cannot always anticipate our readers' interests and accordingly this advance list is published for the benefit of those who may not care to await our judgment and synopsis.

1,439,061—Extraction of Soluble Substances.
1,439,128—Recovery of Phenol Vapors.
1,439,163—Fluid Recording Device.
1,439,171—Method of Treating Oil.
1,439,284—Drier.
1,439,286—Bonded Alumina Refractories.
1,439,291—Ammonia Synthesis.
1,439,292—Catalyst for Ammonia Synthesis.
1,439,293—Cellulose Compounds.
1,439,447—Oxidation of Ferrous Substances.
1,439,505—Production of Smokeless Powder.
1,439,597—Limekiln.
1,439,610—Zinc Coating of Metal.
1,439,656—Pyro Smokeless Powder.

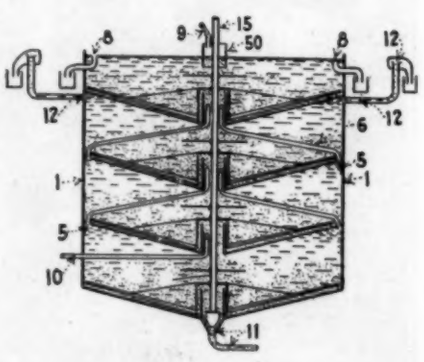
Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Apparatus for the Production of Sodium Sulphate—M. A. Laury has developed a mechanical furnace for producing salt cake (sodium sulphate) and muriatic acid from niter cake (sodium bisulphate) and salt (sodium chloride). The apparatus is shown in the accompanying diagram and consists essentially of an oil burner (1) supplying heat to a rotary kiln. (2) Here the reaction takes place and there is no balling up of the product because of the fact that it is dried very completely in chamber (3), which is a ball mill. Niter cake and salt are fed into the chamber through leads (5) and (6) in proper proportion and the mixture is ground up and preheated in the ball mill before being introduced into the rotary furnace. The gases of combustion together with hydrochloric acid gas escape at (8) through appropriate ducts and the hydrochloric acid gas is absorbed from the waste gases in the usual manner. Finally the sodium sulphate passes out of the furnace at (9). Sometimes it is found desirable to insert some iron balls in the rotary furnace chamber, but this is usually not essential. The combustion chamber, it will be noticed, is fed on cracks so that it may be rolled up to the rotary and rolled away when the rotary needs relining or cleaning. Trouble with mechanical furnaces in the past has usually been that the charge balls up badly and therefore the reaction does not take its ultimate course. This process is said



to overcome the difficulty by preheating in the ball mill. (1,435,930. Nov. 21, 1922.)

The Counter-Current Washing of Finely Divided Solids—N. C. Christensen, Salt Lake City, Utah, has patented a counter-current washing device. The accompanying diagram shows substantially the principle of the washer. It is based on a tray principle, the various sections of the tray being either horizontal, in which case the solid is moved toward the center by means of plows, or inclined, as in the diagram, in which case the solid flows by gravity toward the center. The thickened pulp moves through a tool then to the next lower compartment and meets there an upcoming current of liquid. It will be noted that the upper tray, onto which the mixture of solids and mother liquids is first pumped, is separate from the rest of the washer and the wash water finally overflows at a point just below the level of the top tray. This permits the separation of the wash liquor from the mother liquor, which is frequently desirable. The solids then continue to settle out of the wash liquor on each of the succeeding trays and are washed as many times as there are trays. Finally, they are discharged from the bottom of



the washer by means of another overflow trap. The mechanism is in each case not overly important and the first patent covers merely the general principle involved. (1,434,089. Oct. 31, 1922.)

German Patents

For complete specifications of any German patent apply to the German Patent Office, 97 Gitschinerstrasse, Berlin, Germany.

Blue Vat Dye of the Anthraquinone Series — 1-Mercapto-2-amino anthraquinone or salts of 1-mercapto-2-amino anthraquinone are condensed with 1-chloro-2-amino anthraquinone in the presence of condensing agents which effect condensation at the mercapto-group. Hydrogen sulphide is split off with formation of N-dihydro-1:2:2′:1′-anthraquinoneazine, which latter also results when salts of 1-mercapto-2-amino anthraquinone are heated to a high temperature. (Ger. Pat. 357,767, which is an addition to German patent 356,922. E. Kopetchin.)

Fire-Extinguishing Compounds and Detergent Compounds — Chlorinated hydrocarbons are acted upon with water in Plauson colloid mills or similarly operating impact mills, eventually with addition of small amounts of protective colloids, such as albumens, glue, rubber latex, soaps, and of organic compounds capable of acting as solvents for the chlorohydrocarbons and water. The addition compounds act as dispersing agents. A mixture composed of 1 part of a chlorinated hydrocarbon and, for instance, 3 parts of water has the same fire-extinguishing effect as the pure chlorinated hydrocarbons, besides being distinguished from the latter by a smaller volatility. (Ger. Pat. 358,572. Plauson's Forschungsinstitut, Hamburg.)

Copper Sulphate From Scrap—Mill scrap or similar residues containing Cu as such or in form of alloys are roasted with chlorides, preferably NaCl (maximum 10 per cent), after the manner of the chloridizing roasting process as applied to sulphide ores, and subsequently treated with sulphuric acid. The Cu-containing scrap material is, prior to roasting, comminuted together with the sodium chloride. When tin-containing scrap is subjected to this process, small amounts of lime, SiO_2, Al_2O_3 or their salts are added to the material to be roasted. (Ger. Pat. 358,611. S. Hiller.)

Green Pigments—Nitroso-β-naphthol, preferably in form of its bisulphite compound, is acted upon with ferrous salts, preferably in the presence of turkey-red oil or similarly acting additions, with or without any of the mediums ordinarily used in the manufacture of lacquers. The formation of these mediums may also be caused to take place simultaneously with the production of the green pigment. Valuable pigments may also be obtained with a ferric salt provided the amount of the latter is less than theory requires. Ferric acetate gives valuable pigments even with the full theoretical amount of Fe. The green pigment is remarkably fast to light, water and alkalis, and is to be used in the production of inks for printing wall paper, books, or for lithographic work. (Ger. Pat. 356,973. Badische Anilin u. Soda Fabrik).

Condensation Products From Phenols and Aldehydes—To the reaction mixture a catalyst is added consisting of those phenols which, in addition to the OH-group or groups, contain any basic group or groups. The added catalyst, such as amino-phenols, methyl- and ethylaminophenols, aminonaphthols, hydroxyquinolines, hydroxydiphenylamines, particularly those aminophenols in which the H of the NH_2 or NH group is partly or entirely replaced by an alkyl-, aralkyl- or aryl-radicle, react with the aldehydes such as CH_2O or its polymers, furfuraldehyde, acrolein, in the same way as the phenols, so that they need not subsequently be removed from the final reaction product. For instance, from C_6H_5OH, CH_2O and *p*-aminophenol, or from $C_6H_5.OH$, furfuraldehyde and *p*-aminophenol, homogeneous masses are obtained which are perfectly free from water and bubbles, insoluble and non-fusible, and are readily machined. They are particularly intended for electric insulating purposes. (Ger. Pat. 358,195. Felton-Guilleaume Carlswerk Actien Gesellschaft, Köln-Mühlheim.)

Resinous Condensation Products From Cresols and Xylenols—The cresols or xylenols are treated with oxygen or air in the presence or absence of a catalyst. For instance, a current of moist air is passed for 10 to 12 hours through *o*-cresol heated to 150 to 170 deg. C. or through a phenol-containing crude cresol or *m*-xylenol, in the presence of a small amount of manganese dioxide or ferric chloride. The phenolic constitutents unacted upon are driven off with steam. The resulting resinous material constitutes, according to the duration of the oxidation treatment and the temperature, when air was used, a dark-brown to black mass which is soft, hard or brittle. Even those resins which are hard at the ordinary temperature may be melted by application of heat. By heating to higher temperatures the softer products are converted into highly lustrous, hard and brittle resins. The products are soluble in dilute NaOH, ether, alcohol, acetone and benzol, but practically insoluble in dilute Na_2CO_3 solution and in cold turpentine. The soft resins are also readily soluble in fatty oils, such as olive oil, whereas the hard resins go into solution only after heating or by prolonged action of the cold oil. The reaction presumably takes place in such a manner that at first the alkyl groups of the phenols are oxidized, and the resulting intermediate reaction products yield polymerization products either with each other or together or with unchanged phenols. (Ger. Pat. 357,756. Chemische Werke Grenznach Aktien-Gesellschaft.)

Washing and Bleaching Compound—Sodium peroxide and sodium bicarbonate are mixed together with soluble glass (sodium silicate) preferably in the presence of protective compounds. A 30 deg. Bé. water-glass solution is mixed with NaO_2, and the resulting mass is stirred with slightly more than the equivalent amount of $NaHCO_3$ and the solidified mass is ground and dried. The protective compound to be added to the water-glass solution may be either magnesium or calcium silicate. (Ger. Pat. 357,956. Deutsche Gold und Silberscheideanstalt vorm. Roessler, Frankfurt.)

Liquid or Soluble Organic Compounds From Coal—A coal having a carbon content of not more than 85 per cent (referred to dry, ash-free substance) is subjected to hydrogenation by H_2 under high pressures and high temperatures. About 87 per cent of the coal used is thus converted into liquid or soluble form. No catalyst is used. The coal is subjected to pressure and heat in an atmosphere of hydrogen in the presence of a diluent liquid under the reaction conditions, the diluent used for the starting material to be hydrogenated consisting of high-boiling mineral oils or tar or high-boiling distillates or residues obtained therefrom. Due to the high-boiling diluent local overheating is excluded, and the reaction products are brought into solution. About 88 per cent of the coal is thus brought into a liquid or soluble form. (Ger. Pats. 299,783 and 303,272. Frederick Bergins.)

Conversion of Natural or Synthetic Varieties of Rubber Into Other Varieties of Rubber or Into Masses Resembling Gutta Percha—The hydrohalogen or halogen derivatives of certain kinds of rubber are reduced with metals (Zn) in a dispersive medium such as $CHCl_3$, $C_2H_4Cl_2$, and, if necessary, the resulting masses are washed with water or dilute acids. The resulting rubber has more or less viscous properties, according to the mode of preparation. When ethylene chloride is the dispersive medium, a substance resembling gutta percha is obtained. (Ger. Pat. 354,344. Siemens & Halske Aktien-Gesellschaft.)

Process for Protecting Fur and Wool From Moth and Other Insects—Animal fibers are protected from moth, etc., by treatment with the vapor of α-tetralon (α-tetrahydronaphthaleneketone) or mixtures of this with other suitable substances. The protective effect of α-tetralon is more lasting than that of chlorinated aromatic compounds, since it is less volatile. α-Tetralon is obtainable as an emulsion in soft soap or in the form of a powder, pellets or tables. Paper and fabrics may be treated with solutions of α-tetralon in petroleum spirit of high boiling point. (Ger. Pat. 357,063. Vereinigte Chemische Fabriken J. Norden & Co.)

Ammonium Sulphate From Crude Calcium Cyanamide—$CaCN_2$ is heated with $NaHSO_4$ and H_2O, the residue filtered off, and the liquor evaporated. The proportions of the reacting substances are so adjusted that the solution contains more than 1.3 parts (preferably 3 parts) of Na_2SO_4 to 1 part of $(NH_4)_2SO_4$; on evaporation the whole of the Na_2SO_4 crystallizes out, and by further evaporation of the mother liquor, technically pure ammonium sulphate is recovered direct. (Ger. Pat. 299,131, Bambach & Co.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields
Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Code of Ethics Adopted for Engineers

Joint Committee of Engineering Societies Formulates Principles for Elevation of Dignity of Profession

Adoption of a code of ethics, governing its membership of approximately 20,000, is announced by the American Society of Mechanical Engineers. Ultimately, it is expected, this code, prepared by a joint committee of national engineering societies, will apply to the entire engineering profession, embracing more than 200,000 professional engineers.

The mechanical engineers are the first to adopt the code, according to the chairman of the joint committee, Prof. A. G. Christie of Johns Hopkins University. This action, Professor Christie stated, marks an advance in engineering ideals, and, in respect to the government of its members as a whole, places the profession in a position analogous to the professions of law and medicine.

The code commands loyalty to country, personal honor, fairness to contractors and workers and interest in the public welfare. Betrayal of professional confidences, undignified or misleading advertising and questionable professional associations and practices are prohibited.

Text of Code

The text of the code, as given out by John L. Harrington, president of the American Society of Mechanical Engineers, follows:

"Engineering work has become an increasingly important factor in the progress of civilization and in the welfare of the community. The engineering profession is held responsible for the planning, construction and operation of such work and is entitled to the position and authority which will enable it to discharge this responsibility and to render effective service to humanity.

"That the dignity of their chosen profession may be maintained, it is the duty of all engineers to conduct themselves according to the principles of the following code of ethics:

"1. The engineer will carry on his professional work in a spirit of fairness to employees and contractors, fidelity to clients and employers, loyalty to his country and devotion to high ideals of courtesy and personal honor.

"2. He will refrain from associating himself with or allowing the use of his name by an enterprise of questionable character.

"3. He will advertise only in a dignified manner, being careful to avoid misleading statements.

"4. He will regard as confidential any information obtained by him as to the business affairs and technical methods or processes of a client or employer.

"5. He will inform a client or employer of any business connections, interest or affiliations which might influence his judgment or impair the disinterested quality of his services.

"6. He will refrain from using any improper or questionable methods of soliciting professional work and will decline to pay or to accept commissions for securing such work.

"7. He will accept compensation, financial or otherwise, for a particular advice, from one source only, except with the full knowledge and consent of all interested parties.

"8. He will not use unfair means to win professional advancement or to injure the chances of another engineer to secure and hold employment.

"9. He will co-operate in upbuilding the engineering profession by exchanging general information and experience with his fellow engineers and students of engineering and also by contributing to work of engineering societies, schools of applied science and the technical press.

"10. He will interest himself in the public welfare, in behalf of which he will be ready to apply his special knowledge, skill and training for the use and benefit of mankind."

The joint committee which drew up the code was composed as follows:

American Society of Civil Engineers —C. C. Elwell, New Haven, Conn.; A. M. Hunt, New York.

American Institute of Mining and Metallurgical Engineers — J. Parke Channing and Philip W. Henry, New York.

American Society of Mechanical Engineers—Prof. A. G. Christie, Johns Hopkins University, Baltimore; H. J. Hinchey, Chicago; Charles T. Main, Boston; J. V. Martenis, Minneapolis; Robert Sibley, San Francisco.

American Institute of Electrical Engineers — Prof. Comfort A. Adams, Harvard University; C. Paccioli, Pittsfield, Mass.; George F. Sever, Toronto, Ont.; L. B. Stillwell, New York.

American Society of Heating and Ventilating Engineers—Frank T. Chapman and Perry West, New York; S. A. Jellett, Philadelphia.

Reclassification of Federal Employees Delayed

Although several hearings have been held by a sub-committee of the Senate Appropriations Committee, the final report on the bill to reclassify the employees of the federal government and readjust salaries has not been formed and in view of the heavy work devolving upon the Appropriations Committee because of the annual supply bills, fears are expressed that the reclassification measure will not be brought to action on the floor in time to assure passage at the present session of Congress. Senator Smoot, chairman of the sub-committee in charge of the bill, has stated, however, that a report may be expected shortly.

Friends of the reclassification bill are dubious of its passage in the present Congress, even if a report is forthcoming in January, because of the doubt over the shape in which the bill will appear when it emerges from committee.

Bill Has Had Stormy Career

The Civil Service Committee of the Senate considered this measure some weeks and reported it on Feb. 8 last with a recommendation that it be passed. Because of the financial features of the bill, it was referred to the Appropriations Committee for further study. The Civil Service Committee made a number of changes in the bill from the form in which it was passed by the House. While the sessions of the sub-committee on appropriations have been executive, with a number of government officials testifying as to their ideas, it is generally understood that further changes have been seriously considered by this committee. Senator Smoot himself is the author of another reclassification bill which originally projected reforms based upon a somewhat different theory than those contained in the Lehlbach-Sterling bill, which was the basis of the one now under consideration.

It is said that the Appropriations Committee has been considering further reductions in the number of classes outlined in the bill and that there has been serious thought of eliminating workers in the field and confining the measure to government employees within the District of Columbia. Changes in title and in relative pay for professional and sub-professional workers also have been suggested, it is said, because these men, especially technical workers, are leaving the service in increasing numbers.

Wisconsin Plans Colloid Studies Under Svedberg

Lecture Courses and Symposium Under Swedish Expert Expected to Attract Leaders in Field

The department of chemistry of the University of Wisconsin desires to call attention to the program for colloid chemistry which will be conducted by Prof. Thé Svedberg during the coming semester, commencing Feb. 1, 1923, and summer session, commencing June 25, 1923.

Prof. Thé Svedberg, of the University of Upsala, Sweden, will be in residence at the university from Feb. 1 to Aug. 5. He will give two lectures a week on the general theory of colloids and will direct the experimental researches of a number of graduate students during the second semester. In the summer session the course of lectures given during the second semester will be repeated. Every necessary facility will be provided for the successful prosecution of researches. Those desiring to work under Professor Svedberg's personal direction, either during the second semester or during the summer session, should communicate promptly with Prof. J. H. Mathews, since only a limited number can be accommodated. The opportunity of hearing Professor Svedberg's lectures and doing work under his direction during the summer session will appeal to a great many professors and instructors at other educational institutions. A considerable number have already signified their intention of embracing this opportunity.

Seminary and National Symposium Planned

Professor Svedberg will also conduct a seminary in colloid chemistry which will meet weekly during the second semester. The first half will be devoted to general theory and the second to biological applications of colloid chemistry. In the latter half of the work he will be assisted by Prof. Elmer Sevringhaus, of the department of physiological chemistry. Admission to the seminary will be open to chemistry students who have had a course in physical chemistry and who possess at least an elementary knowledge of the theory of colloids; and to advanced workers in the biological sciences.

From June 12 to 15, inclusive, a national symposium on colloid chemistry will be held at Madison to which all scientists interested in colloid chemistry are invited. A program of exceptionally interesting papers is now being formulated, and definite assurance of the attendance of nearly all of the most prominent American workers in the colloid field has already been given. About twenty papers will be presented by the authors in person and there will be ample time for thorough discussions. These discussions will be led by Professor Svedberg. More detailed information concerning the program of papers to be presented will appear in these columns later.

Fertilizer Manufacturers Confer With Agricultural College Officials

Representatives of fertilizer manufacturers conferred with officials of agricultural colleges and experiment stations from the New England states in Boston, Dec. 30. The officials explained the soil improvement needs of their states and what they are trying to accomplish for the benefit of agriculture. Policies and measures were pointed out, whereby fertilizer manufacturers and their salesmen may cooperate to better advantage.

The conference was called on the invitation of Prof. S. B. Haskell, director of the Massachusetts State Experiment Station. Horace Bowker, vice-president of the American Agricultural Chemical Co., was selected as head of the fertilizer delegation, which included corporation officials, sales managers and field salesmen.

The meeting was in connection with the convention of the American Association for the Advancement of Science, which was held in Boston, Dec. 26 to 30. New England is one of the sections where high-analysis commercial fertilizers have been used to the exclusion of the poorer grades, owing to the nature of the principal crops raised there.

C.C.N.Y. Offers New Courses in Chemistry

The evening session of the College of the City of New York is offering, for the first time, courses in potable and industrial water and the chemistry of commerce in addition to the usual courses in chemistry.

Course 249—"Potable and Industrial Water"—deals with the special analytical work required for the analysis of water and with the interpretation of the findings of the analysis. Some attention is paid to water bacteriology. Prerequisite for this course is quantitative analysis and general bacteriology.

Course 269—"Chemistry of Commerce"—deals with the economics of the production and disposition of chemical products. It treats of the sources of raw materials and markets for the intermediate and finished product. The sources of energy and the conservation of waste by the utilization of byproducts is considered and the patent laws are discussed. Seminar work on the economic history of the development of various chemical industries is included. A knowledge of applied organic and inorganic chemistry is required for admission to this course.

Besides these courses, the regular courses in inorganic and organic chemistry, qualitative and quantitative analysis and electrochemistry will be given, all courses starting about Feb. 8, 1923.

Further information may be obtained from the director of the evening session, College of the City of New York, 139th St. and Convent Ave., New York City.

Customs Official and Coal-Tar Men Confer

Concentrate Efforts on Untangling Snarls in Chemical Schedule of New Tariff Law

Manufacturing interests were represented at a series of conferences on the proposed rules and regulations which if adopted will govern the entry of dyes under the new tariff law, held at the United States Appraiser's Stores in New York, last week.

Experts from the Bureau of Standards, the Treasury Department and the Tariff Commission conferred with importers and their representatives at the conferences. Tentative rules were drafted, and these are now being submitted to all parties interested before being forwarded to Washington for approval and adoption.

Snarl in Cresol Duty

One of the problems with which the customs division of the Treasury Department is wrestling is an apparent conflict between the coal-tar products paragraph of the dutiable list of the new tariff act and the corresponding paragraph of the free list. Congress, in the "inclusive clause" of the dutiable paragraph, created two classifications, while only one is specified in the free list.

The specific case arose over imports of cresol, an intermediate used in a number of medicinal preparations and for some other purposes. This product is not mentioned by name in the tariff act, but falls within the inclusive clause.

In the paragraph placing a duty on intermediates, it is provided that: "All distillates of coal tar . . . which on being subjected to distillation yield on the portion distilling below 190 deg. C. a quantity of tar acids equal to or more than 5 per cent of the original distillate, or which, on being subjected to distillation, yield in the portion distilling below 215 deg. C. a quantity of tar acids equal to, or more than, 75 per cent of the original distillate," shall be dutiable. There are two specifications in this classification, either one of which apparently would make the product dutiable.

Properties of Cresol or Schedule Must Be Modified

The free list paragraph, however, omits the 75 per cent below 215 deg. specification and provides that a product which does not yield 5 per cent or more of the original distillate below 190 deg. C. shall be admitted free. Cresol does not yield 5 per cent below 190 deg., but does yield 75 per cent below 215 deg. This fact would include it in the second specification of the dutiable list but inasmuch as this is omitted from the free list paragraph and below 5 per cent is to be admitted free, appraisers are at a loss as to how to proceed.

A number of other coal-tar products are said to be in a similar position. A decision is not expected in the case for several weeks.

Opportunities for Research in Compiling Critical Tables

Board Encounters Gaps in Available Data Which Make Ideal Subjects for Theses and Research

In preparing for publication the data on physical properties of chemical substances, the editorial staff of International Critical Tables will find from time to time that important physical properties of substances of technical and scientific importance are missing from the literature. As fast as missing data of this character come to light, it is the policy to formulate research problems covering such missing data and to endeavor to interest chemists and physicists in undertaking the necessary investigations to supply the required data.

Most of the research problems formulated in this way will be suitable for bachelors' or masters' theses and in a few instances topics sufficiently broad to be suitable for doctors' theses will also be available. Many of them will be suitable for experimental problems in the ordinary laboratory courses in physical chemistry and physics. Thus, for example, the laboratory experiment covering the determination of solubility might to advantage deal with substances whose solubility is needed but is unknown. The average of the determinations made by a class of students, while not as accurate and reliable as the determinations made by a skilled investigator, will nevertheless be very valuable when they constitute the only data available on the subject. Moreover, the average student will be more interested in a laboratory experiment the results of which are of actual value and worthy of publication than he would be in repeating the measurement of a property of some system which has been measured many times before.

Problems Sought

International Critical Tables will be glad to submit to interested instructors in universities and colleges lists of problems of this character and to advise as far as it can concerning suitable apparatus and methods of measurement. It may be possible also in some instances to secure moderate financial assistance to aid in the purchase of materials and apparatus for investigators interested in carrying out work of this character. The results of such work may be published by the investigator in any appropriate publication medium and they should also be reported in duplicate to the office of International Critical Tables on completion of the work.

Problems Now Available

A number of problems on the following subjects are available at the present date: Heats of combination of solid oxides and iron compounds; specific heats of brass, solid oxides, steels, oils and fats, petroleum products, metals, salts, iron compounds, asphalts; latent heats of fusion of brass and metals; heat conductivity of steels; latent heats of vaporization of petroleum products; viscosities of industrial materials; rates of drying; hydrolysis of industrial materials; catalysis; transpiration of moisture; strength of industrial materials; thermal expansion of steels and iron compounds; freezing-point-solubility diagrams of salts, acids, metals in water and soaps; boiling points of solutions; solubility of gases in molten metals and in water; chemical equilibrium; dissociation pressures at 1,600 deg. C.; electrical conductivity of metals and refractories; properties of colloidal systems; vapor pressures of metals and solutions; specific rotatory power of gliadin; index of refraction of solids; density of certain organic compounds and solutions; flash points and surface tensions of solutions.

Chicago Chemists Observe Pasteur Centennial

Life and Work of Great French Scientist Discussed From Many Angles at Meeting of Chicago Section

In commemoration of the Pasteur Centennial, the meeting of the Chicago section, American Chemical Society, held Dec. 15, was devoted to the life and work of the great French scientist. The address of the evening was delivered by Dr. Edwin O. Jordan, head of the department of bacteriology and hygiene, University of Chicago. In a fascinating manner Dr. Jordan brought out the human side of Pasteur. Much of the work on the preparation of vaccines was carried out only through Pasteur's intense determination to seek scientific truth, for he was so extremely sensitive to suffering in others—whether animals or human beings—that he experienced mental and physical torture during the operations which were necessary for the studies. In view of this phase of his character, the violent attacks made upon him as an inhuman vivisectionist seem to us ridiculous and amusing.

Before the Biologic Group, Dr. Morris Fishbein, associate in medical history, Rush Medical College, read a very interesting paper outlining the development of the Pasteur method of treating rabies—from the preliminary work on animals until the eventful day when the treatment was first applied to a human being. The result was successful and recognition of the value of the method was rapid. It is interesting to note that the treatment used today varies only in perhaps a few unimportant details from that developed by Pasteur.

Topics discussed before the other groups were: "Pasteur and His Work With Polarized Light," W. V. Evans, department of chemistry, Northwestern University; "Pasteur and the Fermentation Phase of the Baking Industry," George L. Teller, Columbus Laboratories; "Organic Mercury Compounds," Lyman Chalkley, Jr., Sprague Memorial Institute.

Development Work on Canadian Tar Sands

Further testing of Athabasca tar sands in the Canadian west on a practical scale is to be carried out during the winter at the laboratories of the University of Alberta in Edmonton, Alta. A report was recently submitted to the Advisory Scientific Research Council of Alberta by Dr. K. A. Clarke, who has been in charge of the experimental work of separating sand from bitumen for the past year or more, and the results therein announced were so encouraging and satisfactory that it was decided to continue along the lines already tried out and to make an actual test in road paving.

Bitumen Paving Material

With the sand brought from the McMurray district of Alberta, Dr. Clarke will apply the water-separation process of extracting the bitumen which he has developed, and will in this way obtain a stock of bitumen which will be available for future use as paving material. Other materials are exceptionally scarce in this district. Dr. Clarke has not had his process patented.

Dr. S. C. Ells of the federal department of mines, who is considered the premier authority in Canada on matters pertaining to the bitumen deposits and who has made a study of this mineral for the past 14 years in the West Indies, the United States, France and other portions of the European continent considers that commercial separation does not present greater difficulties than many other industrial problems which have already been solved satisfactorily. In 1913 Dr. Ells undertook the first systematic study of the McMurray deposits, regarding which at that time probably nothing of a definite nature was known. Since then every outcrop has been examined, accurate samples obtained and analyzed and topographical mapping of large areas completed. During the winter of 1915, in the face of serious difficulties, Dr Ells shipped to Edmonton the first large consignment of the McMurray sand. Subsequently the engineer assembled in Edmonton a small plant, and designed and laid the first pavements in which Canadian tar sands were used on a large scale. The signal success which marked this work demonstrated clearly the value of Alberta tar sands as a material for the surfacing of streets.

Water Separation Feasible

Subsequently realizing that large commercial development would depend upon the evolving of a satisfactory separation process, Dr. Ells spent months in considering the relative values of various separation and distillation methods. Owing to the war this work was not completed, but from the preliminary results obtained it appeared that the uses of heated water to which certain inexpensive reagents were added afforded the best chance of success.

Is Public Ready for Broad Scope in Technical Education?

President of Columbia Reports Signs of Tardy Recognition of Value of Fundamentals of Science and Humanities

President Nicholas Murray Butler of Columbia University, in his annual report to the trustees, says that opinion is moving in the direction of a policy of higher standards of admission and instruction in engineering schools. The time has come, in Dr. Butler's opinion, to give more special and concentrated attention to the advanced and research work of the university in the whole field of engineering.

"The line of separation between pure and applied science is increasingly difficult to discern and maintain," continues Dr. Butler. "The real distinction would appear to lie not so much in the subject matter as in the spirit with which the work of research is carried on.

"The applications in industry and in commerce of the principles and facts which constitute chemistry, physics and mechanics, for example, are made possible only by reason of a thorough understanding of those principles and facts. When research in the field of natural and experimental science was young in the United States, and when the dominant motive and interest of the people were largely material, it was perhaps not difficult to distinguish between what came to be called the field of pure science and that of applied science. Conditions have, however, sharply changed during the past generation, and the intermingling of the two is very considerable, even if it be not complete.

PLACE OF FUNDAMENTALS IN CURRICULA

"The policy of Columbia University in accepting 8 years ago the recommendation of the faculty of applied science to elevate the standard of admission to the Schools of Mines, Engineering and Chemistry, and to turn those schools definitely to the task of training leaders of the engineering profession and research workers, has resulted in greatly reducing the enrollment of students, and has left several departments of instruction overequipped for the work which they have to do, at least during the period when the new policy is establishing itself.

"There are signs that opinion is moving in the direction of the policy that was adopted 8 years ago. The dean of the faculty of applied science points out in his report that the importance attached here at Columbia to the humanities and to fundamental scientific studies as the basis of an advanced technical or professional training is increasingly recognized elsewhere.

MERIT OF LONGER COURSES

"A group of representatives of the most important engineering schools in the Middle Western states have unanimously approved a 5-year program of study for engineering students, with a view to giving the time gained to the study of the humanities and fundamental scientific subjects. Whether the program of engineering study be one of 5 years or 6 years is probably of less importance than its content and the possibility of the fundamental instruction being given by a large number of colleges and scientific schools, many of whose students would naturally transfer to Columbia to complete their engineering course.

"That there is ground for careful examination of all that relates to the program of study in the Schools of Mines, Engineering and Chemistry is obvious, and steps are taken to make that examination in the broadest way possible and with complete sympathy for the ideals which the university has set up."

Civil Service Openings

The United States Civil Service Commission announces open competitive examinations for laboratory assistant, junior grade and senior aid, and for junior chemist. The examinations will be held throughout the United States on Feb. 14 to fill vacancies in the Bureau of Standards, Department of Commerce, Washington, D. C. The entrance salary for laboratory assistant, junior grade, is $1,000 a year, plus the increase of $20 a month granted by Congress; for senior aid, $900 a year, for junior chemists $1,200 to $1,800, also plus the increase. The written examination consists of physics and chemistry, mathematics (through trigonometry) and mechanical drawing. The element of education and experience is weighted at 50 per cent.

The Bureau of Standards covers a wide field of work in physics, chemistry, engineering and industrial technology, and offers unparalleled opportunity for the study of a profession.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or secretary of the Board of U. S. Civil Service Examiners at the post office or custom house in any city.

Improved Service Arranged in Distribution of Fertilizer Statistics

The Bureau of the Census has agreed to the proposal of the National Fertilizer Association that the census of sulphuric acid and of acid phosphate be taken as of Jan. 1, rather than as of Nov. 30. The later date will permit the compilation of much more representative figures, it is contended. The association also pointed out the increased worth of the figures if there is no delay in making them public. In that connection the bureau is in a position, it was stated, to make the figures available forty-eight hours after the last return has been received. The fertilizer association is co-operating in an effort to obtain prompt answers to the questionnaire and a high percentage of responses.

Copper and Brass Research Association Summarizes First Year's Activity

In connection with the conclusion of the first full year of the Copper and Brass Research Association's activity as an unincorporated, voluntary organization of the brass and copper industries R. L. Agassiz, president of the Calumet & Hecla Mining Co., who is president of the association, said, at the meeting on Dec. 5:

"The research and educational work of the Copper and Brass Research Association has played an important part in the rapid growth of consumption of brass and copper during the past year —for, despite uncertain business conditions, copper consumption in this country is now substantially greater than in pre-war years. Having digested an unprecedented quantity of war-time scrap metal, the industry is now in a strong position.

"Our plan is to provide through the instrumentality of the Copper and Brass Research Association a technical and advisory service which may be freely called upon by users of our metals—a service which no one copper or brass producer or manufacturer could reasonably be expected to undertake alone.

Officers for the coming year were elected as follows: President, R. L. Agassiz; vice-presidents, C. F. Kelley, F. S. Chase, E. J. Rowland, Walter Douglas and U. T. Hungerford; treasurer, Stephen Birch; secretary, G. A. Sloan; and manager, William A. Willis.

Fertilizer Association Plans Annual Convention

With the idea of making its annual convention one of the features of next year's work, the National Fertilizer Association already is taking steps to that end. The executive committee of the association has fixed the time of the convention for the week of June 10. It will be held at White Sulphur Springs. Particular attention is to be given at this convention to the whole subject of cost accounting.

The executive committee at its meeting considered that portion of the report which the uniform cost-accounting committee has completed. At the same meeting John I. Tierney, the Washington representative of the association, reviewed the car and traffic situations.

Philadelphia Chemical Club Plans Course for Salesmen

The Philadelphia Chemical Club is perfecting plans for a course of instruction in chemistry for chemical salesmen, covering primarily a comprehensive series of lectures of practical value to men selling chemical products of various kinds. A committee was appointed to arrange for the proposed course, developing the important details and topics for lectures. Officers of the society elected for the coming year are: John H. Stutt, Jr., president; F. S. Havens, vice-president; W. H. Davis, secretary; and W. J. Thorne, treasurer.

Chemistry Fundamental to National Defense

Assistant Secretary of War Recognizes Importance of Industry to Welfare of Country in War or Peace

Assistant Secretary of War Wainwright, in a recent issue of the United States Army *Recruiting News*, recognizes the fundamental importance of the chemical industry to the national defense. This evidence of growing appreciation of the value of a highly developed chemical industry and chemical research is of special interest in view of Mr. Wainwright's recent action in appointing an advisory board of chemical engineers from the industry.

"Being charged as I am by law with the responsibility of making adequate provision for the mobilization of material and industrial organizations essential to wartime needs," says Mr. Wainwright, "I have taken certain steps which may be interesting to describe briefly to you. The War Department exists in time of peace largely for providing for the defense of the country in time of need. Therefore it is necessary in time of peace to make plans for war. I am therefore giving a great deal of attention to planning how to utilize the commercial industries of the country to best advantage in time of war.

All Warfare "Chemical"

"As Assistant Secretary of War I am charged by law with the 'supervision of procurement of all military supplies and all other business of the War Department pertaining thereto and the assurance of adequate provision for the mobilization of material and industrial organizations to wartime needs.' This responsibility makes the 'relations of the chemical industry to national defense' of paramount interest to me. The requirements of the War Department in time of war for material produced directly or indirectly by the chemical industry of this country are stupendous in size and multitudinous in range.

"There has been a popular use in the last few years of the term 'chemical warfare' as pertaining solely to the use of poison gases and other gaseous materials. Practically all modern warfare is 'chemical warfare.' Chemistry is just as seriously involved in high explosive ammunition, in shrapnel and in high explosive drop bombs as it is in poison gas. The manufacture of smokeless powder and high explosives, of which hundreds of millions of pounds are used in a year in modern warfare, are chemical processes involving chemically educated people, chemical facilities and chemical principles.

Importance in Munitions

"In fact, the most important contribution of chemical industry is its contribution toward the supply of munitions, and therefore I shall touch more fully upon that particular phase than any other. We have had it impressed upon us by the last war that munitions are the controlling factor in exerting a nation's maximum effort in combat. Man power can be mobilized and trained and placed in the field almost a year before the necessary munitions can be manufactured and supplied to them. Therefore, it becomes of paramount importance to the War Department to utilize every industry to assist in expediting munitions production."

New Denaturing Formula for Motor Fuel Alcohol

Approval of Gasoline as Denaturant Should Reduce Cost of Product to Compete With Gasoline

A new formula for the marketing of ethyl alcohol for use as a motor fuel has been approved by the prohibition unit of the Treasury Department. Manufacturers of industrial alcohol believe it will reduce the cost of the blend to a point where it may be sold in competition with gasoline and thus enlarge the field of their product.

The formula is simple, being merely one part of gasoline, of specified grade, to 100 parts of alcohol, the gasoline rendering the blend unfit for human consumption. Heretofore, the principal formula for industrial alcohol for use as a motor fuel has been 95 per cent alcohol blended with 5 per cent benzol, ether and alcohol.

The quantity of alcohol used as a motor fuel in the United States at present is small, but considerable was used during the war, although it is said that alcohol is used more than gasoline in Hawaii. The new formula was evolved by an industrial alcohol manufacturer who foresees that the increasing consumption of gasoline is creating an inviting field for a competitive motor fuel.

The new formula, drawn by Dr. J. M. Doran, head of the industrial alcohol division of the prohibition unit, and signed by D. H. Blair as commissioner of internal revenue, follows:

> The following formula, to be known as specially denatured alcohol Formula No. 28-A, is hereby authorized for use in the manufacture of motor fuels:
>
> To every 100 gal. of ethyl alcohol of not less than 198 deg. proof add 1 gal. of gasoline of the quality specified below:
>
> Volatility and distillation range: When 5 per cent of the sample has been recovered in the graduated receiver, the thermometer shall not read more than 65 deg. C. nor less than 50 deg. C. When 50 per cent has been recovered in the receiver, the thermometer shall not read more than 95 deg. C.
>
> The distillation test above outlined shall be made in the apparatus and in the manner described in Navy Department Specifications 7GI, dated Oct. 2, 1922, particularly referring to Grade A, fighting aviation gasoline.

The blending must be at the point of manufacture.

Distribution of Fertilizer in Pennsylvania

The Bureau of Chemistry of the Department of Agriculture of the Commonwealth of Pennsylvania has issued a report showing a distribution of 325,000 tons of fertilizer and 275,000 tons of agricultural lime among the farmers of the state in 1921, with an approximate gross value of $12,000,000.

Paper Industries Show Scheduled for Spring

Grand Central Palace Will Be Scene of Newest Addition to Industrial Expositions

A new venture, of particular interest to the pulp and paper industry, is announced by the International Exposition Co., which will conduct a "Paper Industries Exposition" in the Grand Central Palace, New York, during the week of April 9, 1923. The executive committee of the American Paper and Pulp Association recently came to the conclusion that such a project would be well received by the industry and voted to support the undertaking. Accordingly, the International Exposition Co. is planning a "paper show" along the same lines as the chemical and other expositions, which have become institutions. The time was chosen so that the exposition would be held during the same week as the meeting of the American Paper and Pulp Association, the National Paper Trade Association and other associations of the paper industry.

The exposition will tell the complete story of paper, starting from the forest and the measures used to prevent waste, to encourage reforestration of cut-over lands to insure a supply of paper raw material for the future, the handling of the raw materials entering into paper, through the machinery with auxiliary apparatus and instruments with which the finished paper is made and the various products therefrom. Among the latter will be shown the newest products of the paper maker and converter.

A committee has been organized for the exposition, comprising organized and unorganized groups of paper manufacturers, the trade publications, educational institutions, engineers and manufacturers of paper machinery. The committee comprises: Hugh P. Baker, secretary American Paper and Pulp Association; H. J. Berger, Editor *Paper Trade Journal*; Charles N. Bicknell, president National Paper Trade Association; F. D. Cowdery, Albany Felt Co.; Joseph L. Fearing, International Paper Co. of Chicago; Hardy S. Ferguson, paper mill engineer; E. B. Fritz, publisher of *Paper Industry*; Phil A. Howard, president American Paper Merchants; C. W. Hurtubis, Hammermill Paper Co.; Thomas J. Keenan, editor of *Paper*; Ralph H. McKee, Columbia University; John H. O'Connell, president American Pulp and Paper Mills Superintendents' Association; Frank W. Power, National Paper Trade Association; L. D. Post, publisher of *Paper Mill*; Walter J. Raybold, president American Paper and Pulp Association; George W. Sisson, Jr., Racquette River Paper Co.; E. C. Spear, Cheney Bigelow Wire Works; Tom Walden, editor of *U. S. Paper Maker*; George E. Williamson, president Technical Association, Pulp and Paper Industry; Louis E. Wise, N. Y. State College of Forestry; Fred W. Payne and Charles F. Roth, managers.

Calcium Arsenate Supply Adequate

Federal Inquiry Believed to Have Established Absence of Corner in Arsenic

Ample calcium arsenate will be available by the time it is needed for use in boll weevil control next summer. This is understood to be the finding of the representatives of the interested bureaus who made an intensive study of the situation in response to a Congressional resolution. The report probably will go to Congress before the end of January.

The shortage of calcium arsenate in 1922 resulted in the loss of cotton which could have been marketed for sums variously estimated from $5,000,000 to $100,000,000. As a result there is strong pressure on the federal bureaus concerned with the production, use and manufacture of arsenic and its compounds. An effort will be made to prevent a recurrence of such a shortage. The studies which have been made by the government's specialists indicate that unusual combinations of circumstances prevented a correct estimate of the 1922 demand for the poisons of which arsenic is the base.

SHORTAGE DUE TO SUPPLY AND DEMAND

There is no tendency to attach blame to the manufacturers of these products. There is no evidence that there was any concerted effort to advance prices. The fact that the 1921 demand for these materials was abnormally small left large stocks at the close of that year. With these stocks on hand, producers naturally did not enter into large output for 1922. Their failure to make contracts caused the price to slump to the point where it no longer was profitable for the smelters to refine their gray arsenic. The demand which wiped out the stocks came suddenly, with the result that production could not be brought quickly to the point necessary to supply the demand. It is believed that conclusions along these lines will be laid before Congress. It is probable that the prediction will be made that ample supplies of calcium arsenate, lead arsenate and paris green will be available to the cotton, fruit and truck growers, respectively, in time for their 1923 crops.

Countervailing Duties Fixed for Canadian Chemical Imports

The Treasury Department has declared countervailing duties on several chemicals when imported from Canada, to equalize the difference between the rates named in the new United States tariff and the corresponding duties imposed by the Canadian tariff on imports from this country. These rates are: calcium acetate, crude; calcium nitrate, cyanamide or lime nitrogen, 17½ per cent ad valorem, unless they are to be used as fertilizers, when they are entitled to entry at 10 per cent ad valorem.

U. S. Sulphur Producers Make Bid for Export Trade

That the sulphur producers of the United States intend to become even a greater factor in the world market is indicated by the formation of the Sulphur Export Corporation. The Union Sulphur Co., the Freeport Sulphur Co. and the Texas Gulf Sulphur Co. are members of the association, as are the following individuals: Henry Whiton, Clarence A. Snider, Eric P. Swenson, S. Magnus Swenson, Walter H. Aldridge and Wilbur Judson. Mr. Snider is president of the corporation, S. Magnus Swenson is vice-president, James T. Kilbreth secretary, and Charles W. Kemmler treasurer. All of the individuals mentioned reside in New York.

Sulphur to the extent of $30,000,000 was shipped from American mines in 1920. During that year the exports of sulphur were valued at $8,994,350.

Personal

Prof. E. C. BINGHAM, Lafayette College, has been elected chairman of the Lehigh Valley (Pa.) section of the American Chemical Society, Allentown. Dr. C. WITMER has been elected vice-chairman; Dr. A. BOGUE secretary and treasurer; and JOHN T. LITTLE councilor.

C. L. BRYDEN spoke on "Filters and Filtration" at the Gayley Chemical Laboratory of Lafayette College, Dec. 14.

W. D. COLLINS spoke before a joint meeting of Committee C-7 of the A.S.T.M. and Philadelphia section of the American Chemical Society on Nov. 17. His topic was "Hardness of Large Public Water Supplies in the United States."

CHARLES C. CONCANNON, acting chief, chemical division, Bureau of Foreign and Domestic Commerce, Washington, D. C., was in New York City conferring with representatives of the chemical industry during the week of Dec. 25.

Dr. EDWARD C. FRANKLIN, professor of organic chemistry of Leland Stanford Junior University, has been elected president of the American Chemical Society, succeeding Dr. Edgar F. Smith, of the University of Pennsylvania.

E. B. GERMAIN has been elected president of the Dunlop Tire & Rubber Corporation of America, with local plant on the River Road, Buffalo, N. Y.

Dr. ARTHUR A. HAMERSCHLAG has been elected president of the Research Corporation, vice Elon H. Hooker, resigned.

G. OENSLAGER, of the B. F. Goodrich Co., addressed the Cleveland section of the American Chemical Society, Dec. 27, on "The Rubber Plantation Industry in the Far East and the Preparation of Rubber."

CLARENCE W. POTTEIGER, of Reading, Pa., formerly city chemist and assistant engineer in the State Department of Health, engineering division, has been appointed secretary of the State Engineering Board, Harrisburg.

RICHARD PENFIELD, formerly chief engineer in the research department of The Barrett Co., has recently joined the engineering force of the Grasselli Chemical Co. at Cleveland.

AUGUST STAUDT, president of the Perth Amboy Tile Works, Inc., Perth Amboy, N. J., has been elected president of the local New Jersey Clay Miners' & Manufacturers' Association.

Prof. THE SVEDBERG, of the University of Upsala, will be in residence at the University of Wisconsin from Feb. 1 to Aug. 5, 1923. He will give a course of lectures on the general theory of colloids and will direct the experimental researches of graduate students.

GEORGE H. TABER, JR., has resigned as president of the Sinclair Crude Oil Purchasing Co., Philadelphia, Pa., to take active charge of the new oil refinery now in course of construction at Marcus Hook, Pa., for the parent organization, the Sinclair Refining Co.

JOHN MORRIS WEISS, until recently director of development of The Barrett Co., and CHARLES RAYMOND DOWNS, formerly chief chemist of The Barrett Co. and more recently engaged in special plant development work at the Buffalo plant of the National Aniline & Chemical Co., have formed a partnership as consulting chemists and chemical engineers under the name of Weiss & Downs. They have taken an office in the Chemists' Building, 50 East 41st St., New York City, and will shortly have laboratory facilities available there. Both of them are known for their inventions in the fields of coal-tar products, synthetic organic chemicals and catalysis. Recently they received an award of the Howard N. Potts gold medal from the Franklin Institute for the production of maleic acid by the catalytic oxidation of benzene.

Obituary

HERBERT H. HEWITT, founder and president of the Hewitt Rubber Co., Buffalo, N. Y., died at his home Dec. 19, aged 67 years.

FRED A. MARSH, general purchasing agent of the Link-Belt Co., died Dec. 11, at the age of 52, at his home in Chicago. Mr. Marsh was a member of the Link-Belt organization for over 33 years and was one of the organizers of the Purchasing Agents Association of Chicago, serving as its first president.

Market Conditions

In Chemical, Metallurgical and Allied Industries

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities
Prevailing Prices and Market Letters From Principal Industrial Centers

Business Conditions in 1922 and the New Year's Prospects

Volume of Production During the Past Year Has Been Satisfactory, Although Not Always Profitable—Outlook for 1923 Is for Greater Stability and Continued Activity

LOOKING BACK over 1922, the reviewer cannot help but be impressed by the substantial gains which have been made in the general business situation. Following the drastic deflation of 1920 and the subsequent depression, it was necessary for business to undergo many fundamental readjustments. And it was these changes that characterized 1921 and the early part of the year just passed. But as the stocks of raw materials and finished products which had piled up during 1921 began to disappear with the first approach of business revival, a very insistent demand for production was developed. At first affecting only the more basic industries, this demand gradually spread until it affected practically every line of business. Furthermore, since this manufacture was almost entirely for current consumption, it may well be expected that the increased productive activity will continue on into the new year.

The improvement during 1922 was made in the face of labor troubles of unprecedented severity, of a discouraging lack of favorable developments abroad and of a serious maladjustment of commodity prices that drastically curtailed the buying power of the country. With these obstacles largely removed, however, and a comparative stability attained both in production and distribution, the new year brings with it every prospect for further improvement both as regards volume of business and the margin of profit in its operation.

Some Comparisons With 1921

Production of manufactured commodities in 1922 was about 50 per cent greater than in 1921, according to figures compiled by the Department of Commerce. Textile mills were about 20 per cent more active than in 1921, the iron and steel industry increased its output from 60 to 70 per cent over 1921, non-ferrous metals from 50 to 95 per cent, petroleum 15 per cent, coke 40 per cent, paper 20 to 30 per cent, rubber 40 per cent, automobiles 50 per cent, building construction 50 per cent, lumber 35 per cent, brick 50 per cent, cement 15 per cent, leather 20 per cent, sugar 45 per cent, and meats about 5 per cent. Agricultural receipts were in general higher than in 1921. The only declines of outstanding importance were 7 per cent in bituminous coal and 47 per cent in anthracite.

The adjusted index for the volume of manufacture, which is compiled monthly by the Harvard Economic Service, stood at 99.7 for October, 1922, an increase of 6.3 over September and the highest point reached since September, 1920. This rise in the general index, it was pointed out, was due primarily to an increase among the industries producing basic commodities. Thus the Harvard index of basic commodities, which is shown in Fig. 1, rose from 97.3 in September to 102.8 in October, the highest figure reached since June, 1920. The prediction is made that further expansion is to be expected during the first half of 1923.

It is interesting to note that textiles and leather, two industries that are numbered among the largest consumers of chemicals, are now showing record activity. Thus for textiles the index was 117.6, the highest in nearly 3 years. The leather index was 106.8 coincident with the greatest activity since the middle of 1919. With the lower prices for hides and the relatively stable leather market, the tanner's margin of profit has been materially improved.

Employment conditions, perhaps better than any other factor, indicate the change in industry that has occurred since the beginning of 1922. The story in brief is a transformation from widespread unemployment to an acute labor shortage. The 3,233 establishments that report the volume of their employment to the Department of Labor are among 43 manufacturing industries and employ 1,556,537 persons. For each month since August there has been an increase over the preceding month. In November increases in the total number of employees were shown in 31 of the 43 industries. In the 42 establishments that produce chemicals there was a gain of 3.5 per cent in the number of employees and of 1.7 per cent in the amount of the payroll. Among other *Chem. & Met.* industries to show gains are the following: Glass 5.7 per cent in number and 8.6 per cent in amount, iron and steel 2.4 and 8.0 per cent, leather 2.8 and 3.8 per cent, pulp and paper 1.1 and 1.0 per cent and petroleum 3.4 and —5.2 per cent (a decrease).

Wholesale prices have made a gradual rise in 1922 and the index number of the Department of Labor is over 10

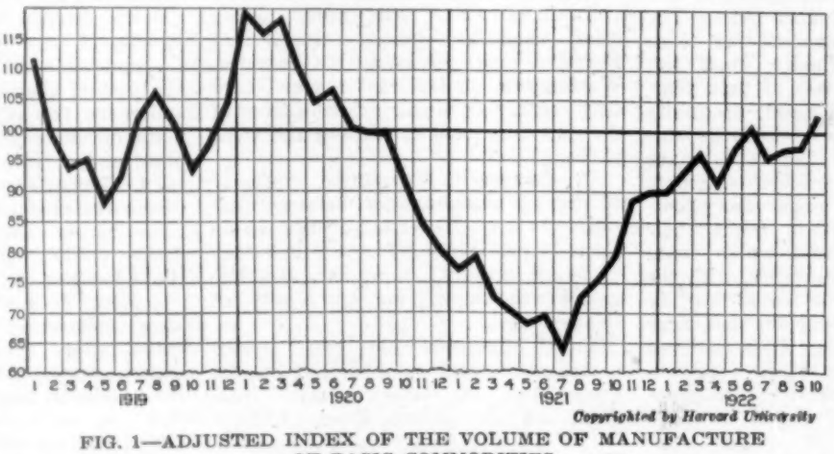


FIG. 1—ADJUSTED INDEX OF THE VOLUME OF MANUFACTURE OF BASIC COMMODITIES

"Chem. & Met." Weighted Index of Chemical Prices

Base = 100 for 1913-14

This week	171.30
Last week	168.35
January, 1922	144
January, 1921	181
January, 1920	242
April, 1918 (high)	286
April, 1921 (low)	140

The sharp advance in this week's index number is attributable chiefly to the rise in the price of cottonseed oil and bleaching powder—two of the most important commodities on the list. Slightly lower prices were noted for glycerine and citric acid.

per cent greater than a year ago. Farm products and metals had the greatest relative gains. The index numbers of *Dun's* and *Bradstreet's* showed larger increases during the year, the former rising 13 per cent and the latter 21 per cent.

An increase during November from 154 to 156 in the "all commodities" index of the Bureau of Labor Statistics brings this figure to the highest level since February, 1921, as will be noted in the accompanying chart (Fig. 2). This price curve has shown a tendency to flatten out in recent months and it is this apparent stability that has most favorably affected business.

Chemical Prices

Chemical prices, on the other hand, have followed a somewhat less regular course. After paralleling the general curve in its precipitous drop during the first 5 months of 1921, the *Chem. & Met.* weighted index of chemical prices showed a reaction to fairly high levels until October. Another slump, however, which reached its low point in February, 1922, brought the index number down almost to the previous low point in May, 1921.

From January until June of the present year there was a rapid improvement, but this was directly followed by a decline during the summer months of over 10 points. The greater industrial activity that began in October and to some extent the passage of the new tariff on Sept. 21 have been largely responsible for the sharp advances that have resulted in an increase of 17 points since Oct. 1. The trend is clearly shown in Fig. 2, in which chemical prices are compared with those of all commodities.

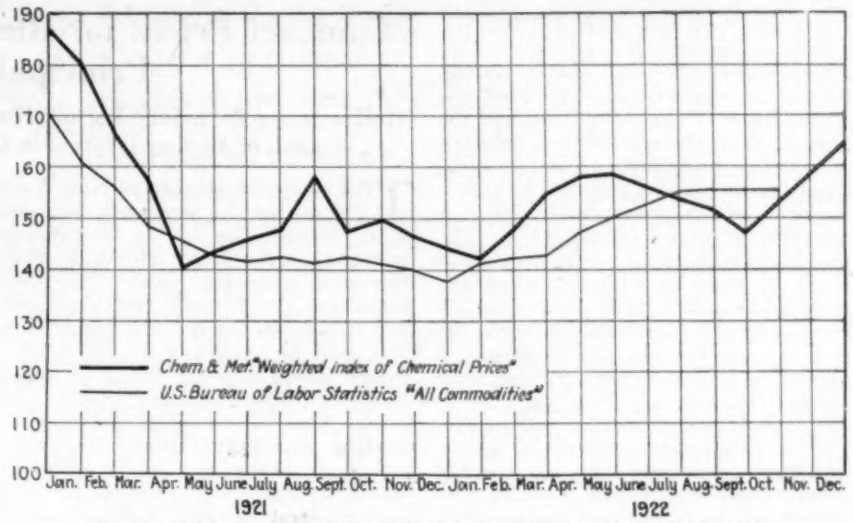


FIG. 2—THE TREND OF WHOLESALE PRICES IN 1921 AND 1922

The Chemical and Allied Markets in 1922

Higher Prices and a More Stable Market Are the Features of a Review of the Year's Activity Among the Sellers of Chemicals and Related Materials

AT THE CLOSE of 1922 the entire chemical list, with the exception of a few commodities of minor importance, were at much higher levels than at the beginning of the year. Although business in general was not up to the expectations of most of the producers, the market was more stabilized and prices throughout were well sustained.

The most important features of the year were the sharp advance of all wood chemicals and solvents and the rise in insecticide prices. Methanol, quoted at 61c. per gal. in January, was advanced to $1.23 in December. This advance affected all acetates and most of the solvents. Calcium acetate advanced from $1.75 per 100 lb. to $3.50. Formaldehyde, quoted at 10½c. in January, was steadily advanced to 16c. per lb. in December. Fusel oil showed a gain of $1 per gal. for the year. Prices opened at $2.50 and closed at $3.50 per gal. Amyl acetate was also advanced from $2 per gal. to $2.80. Glacial acetic acid showed a gain of 3c. per lb. for the year. All other grades were advanced on the same basis.

COMPARISON OF THE AVERAGE MONTHLY PRICES IN THE NEW YORK MARKET FOR 45 IMPORTANT CHEMICALS

Article	Unit	Average Price for Month of— Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Acetic acid, glacial	Lb.	$0.10	$0.09	$0.09	$0.09	$0.09	$0.08½	$0.09½	$0.12	$0.11½	$0.11	$0.11½	$0.13
Muriatic acid, 20 deg.	100 lb.	1.25	1.15	1.15	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.00	1.00
Nitric acid, 40 deg.	Lb.	.06½	.06½	.06½	.06	.06	.06	.06	.06	.06	.06	.05	.05½
Oxalic acid	Lb.	.14	.14	.14	.11½	.13½	.14	.14½	.16	.17	.14½	.14½	.13½
Sulphuric acid, 66 deg.	Ton	16.50	16.00	16.00	17.00	15.50	15.00	15.00	14.50	15.00	15.00	14.50	14.50
Acetate of lead	Lb.	.10½	.10½	.09½	.09½	.09½	.09½	.09½	.10½	.10½	.11½	.12	.12
Ammonia alum, lump	Lb.	.03½	.03½	.03½	.03½	.03½	.03½	.03½	.03½	.03½	.03½	.03½	.03½
Aluminum sulphate, iron free	Lb.	.02½	.02½	.02½	.02½	.02½	.02½	.02½	.02½	.02½	.02½	.02½	.02½
Sal ammoniac, white gran.	Lb.	.06½	.06½	.07	.07	.07	.06½	.06½	.06½	.06½	.06½	.06½	.06½
Ammonium sulphate	100 lb.	2.35	2.50	3.25	3.75	3.60	3.30	3.50	3.55	3.75	3.65	3.60	3.60
Amyl acetate	Gal.	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.35	2.35	2.35	2.80
Arsenic, white powder	Lb.	.07	.07½	.07½	.07	.07	.07½	.08	.08½	.08½	.10½	.13	.16
Barium chloride	Ton	50.00	56.00	75.00	95.00	105.00	93.00	90.00	87.00	95.00	100.00	95.00	94.00
Bleaching powder	100 lb.	2.25	2.10	1.75	1.60	1.60	1.60	1.60	1.60	1.90	2.00	2.00	2.25
Calcium acetate	100 lb.	1.75	1.75	1.75	1.75	1.75	1.75	2.35	2.35	2.35	3.00	3.50	3.50
Camphor	Lb.	.90	.92	.90	.82	.79	.79	.80	.82	.83	.86	.90	.93
Copperas	Ton	15.00	15.00	15.00	15.00	20.00	20.00	20.00	20.00	20.00	20.00	25.00	25.00
Copper sulphate, crystals	100 lb.	5.65	5.60	5.55	5.50	5.75	6.00	6.50	6.50	6.00	5.75	5.75	6.00
Epsom salts, U.S.P.	100 lb.	2.65	2.65	2.60	2.50	2.50	2.50	2.00	2.00	2.00	2.00	2.50	2.50
Formaldehyde, 40%	Lb.	.10½	.10	.08½	.08½	.08½	.08½	.07½	.08	.09½	.13½	.14	.16
Fusel oil, refined	Gal.	2.50	2.50	2.50	2.15	2.15	2.25	2.25	2.25	2.75	2.75	3.00	3.55
Glaubers salt	100 lb.	1.25	1.15	1.00	.85	.90	.95	.90	.90	.85	.85	.85	.85
Glycerine, c.p.	Lb.	.16½	.16½	.16	.15½	.15	.14½	.15½	.16½	.17½	.18½	.18½	.18½
Methanol, 95%	Gal.	.61	.59	.58	.57	.57	.57	.57	.57	.60	.90	1.00	1.23
Nickel salt, single	Lb.	.12	.11	.11	.11	.11	.10½	.10	.11	.12	.12	.12	.11
Phosphorus, red	Lb.	.45	.45	.45	.45	.45	.45	.45	.45	.45	.40	.40	.35
Potassium bichromate	Lb.	.10½	.10½	.10½	.10½	.09½	.09½	.09½	.10½	.10½	.10	.10	.09½
Potassium bromide, gran.	Lb.	.14	.13½	.18	.17	.17	.17	.17	.17	.17	.17	.17	.17
Carbonate of potash, 80-85%	Lb.	.04½	.04½	.04½	.05	.04½	.05	.05	.05	.05	.06	.06	.05½
Chlorate of potash, crystals	Lb.	.05½	.05½	.05½	.06½	.06½	.06½	.06½	.06½	.07½	.07½	.07½	.07½
Caustic potash, 88-92%	100 lb.	6.00	5.75	6.00	5.80	5.85	5.75	5.50	5.50	6.50	6.25	6.50	6.25
Permanganate of potash, U.S.P.	Lb.	.14	.13½	.15	.15	.14½	.14	.14	.13	.15½	.16	.16	.16
Prussiate of potash, yellow	Lb.	.25	.25	.26	.27	.31	.32	.31½	.32½	.36	.37	.38½	.38
Salt cake, bulk	Ton	17.00	17.00	17.00	18.00	20.00	20.00	20.00	18.00	25.00	25.00	25.00	25.00
Soda ash, light, 58%	100 lb.	1.75	1.70	1.80	1.80	1.90	1.80	1.75	1.75	1.75	1.75	1.75	1.75
Bichromate of soda	Lb.	.07½	.07½	.07½	.07½	.07½	.07½	.07	.07½	.07½	.07½	.07½	.07½
Fluoride of soda	Lb.	.10½	.09½	.09½	.09½	.09	.10	.09½	.09½	.09	.09	.09½	.09
Cyanide of soda	Lb.	.26	.23½	.23½	.22	.22	.22	.21	.19½	.19½	.19½	.19½	.19½
Caustic soda, solid 76%	100 lb.	3.25	3.35	3.65	3.65	3.85	3.80	3.60	3.70	3.60	3.45	3.50	3.50
Nitrate of soda	100 lb.	2.37½	2.37½	2.85	2.90	2.70	2.55	2.60	2.50	2.40	2.45	2.45	2.57½
Prussiate of soda	Lb.	.17½	.18	.17½	.16½	.21	.22	.21	.20½	.23	.23	.21½	.19
Sulphide of soda, 60%	Lb.	.04½	.04½	.04½	.04½	.04½	.04½	.04½	.04	.04½	.04	.04	.04½
Sulphur, crude	Ton	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00
Zinc chloride, gran.	Lb.	.09	.09	.06	.05½	.05½	.06	.06	.06	.06	.06	.07	.07
Zinc oxide	Lb.	.07½	.07½	.07½	.07½	.07½	.07½	.07½	.07½	.07½	.07½	.07½	.07½

Arsenic was the most outstanding single commodity of the entire list. Prices showed very little change during the first 6 months, but September importations were unusually small and the demand from the agricultural industry increased considerably. Domestic producers tried hard to keep prices within the reach of consumers, but speculative interests advanced quotations to 16c. per lb. There seems to be very little relief in sight and higher prices are quite probable for 1923. Lead arsenate was advanced in sympathy with the arsenic scarcity and prices showed a gain of 8c. per lb. January figures were around 15c. per lb. They declined to 13c. in July and closed the year at 21c. per lb. Prussiates showed a strong tendency, especially in the potash group. Yellow prussiate of potash was quoted at 24c. in January and continually advanced to 38c. per lb. Red prussiate opened the year at 30c. per lb. and rose to 92c. per lb. at the close.

The alkali market for export was a complete disappointment to producers. The only relief was the very active demand for domestic consumption. Alkali prices showed little variance for the year, with January figures at $3.25 per 100 lb. and December prices at $3.50 for caustic soda. Soda ash held at $1.75 per 100 lb. throughout. Bleaching powder became quite active during the past 2 months and producers reported a heavily sold up market at the works. Prices are due for a rise early in 1923, in view of the strong demand and the pronounced scarcity.

Contract Prices for Bleach are Advanced by the Principal Producers

Holidays and Inventory Period, However, Are Responsible for a General Lack of Buying Interest in the New York Chemical Market

THE chemical market in New York City during the past week has been quite inactive, due to the intervening holidays and the inventory period. Producers of bleaching powder, however, announced an advance for contracts and future shipments and reported a well sold up condition at the works. Second hands have not shown an eager desire to dispose of any stocks and buyers have found some difficulty in locating round quantities. Manufacturers of alkalis and heavy acids reported a satisfactory volume of contract business for 1923 and were quite optimistic regarding business conditions for the new year. Arsenic still remains the bright spot of the market, with spot supplies practically extinct. Formaldehyde prices are being well sustained at recent levels. Prussiates have shown a tendency to ease off and both the potash and soda were fractionally lower. Barium chloride, caustic potash, permanganate of potash and copper sulphate were somewhat firmer at slightly higher levels.

High Spots of the Market

Arsenic—Spot transactions were quite scarce due to the limited stocks. Futures were quoted at 15@15¼c. per lb. January delivery. The general range, however, was around 16@16¼c. per lb.

Bleaching Powder—Producers announced an increase due to the strong demand and scarcity of stocks. Prices range around $2 per 100 lb., f.o.b. works, large drums, for futures and contracts. Spot quotations were heard at $2.25 per 100 lb., in large drums.

Copper Sulphate—Producers have advanced quotations ¼c. per lb. for large crystals, due to the heavy demand for agricultural and export purposes. Quotations range around $6@$6.25 per 100 lb.

Caustic Soda—Buying has slackened considerably for spot requirements and the only business consummated is for contract over 1923. Producers quote futures at $2.50 per 100 lb., basis 60 per cent, f.o.b. works, carload lots. Export quotations range around $3.50@$3.60 per 100 lb. standard brand.

Formaldehyde—Resale stocks have greatly diminished and the best price heard on spot was 16c. per lb. Producers quote carload lots at 16c. per lb. and lesser quantities at 16¼c. The demand continues quite active.

Prussiate of Soda—Demand has eased off considerably and prices were quoted down to 19c. per lb. on spot. Some stressed lots were heard as low as 18½c.

COMPARISON OF THE AVERAGE MONTHLY PRICES IN THE NEW YORK MARKET FOR 35 IMPORTANT COAL-TAR PRODUCTS

Article	Unit	Average Price For Month of— Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Benzene, c.p.	Gal.	$0.29	$0.29	$0.29	$0.29	$0.29	$0.30	$0.30	$0.30	$0.30	$0.30	$0.30	0.30
Cresylic acid, 95-97%	Gal.	.60	.45	.45	.48	.48	.50	.51	.51	.51	.55	.55	.55
Dip oil, 25%	Gal.	.31	.27	.24½	.24	.24	.24	.24	.24	.24	.25	.25	.25
Solvent naphtha, water, white	Gal.	.25	.25	.25	.25	.25	.27	.27	.27	.27	.27	.37	.37
Toluene, water, white	Gal.	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.40	.40
Xylene, pure	Gal.	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.45	.45
H acid	Lb.	.97	.90	.85	.85	.85	.85	.85	.75	.72	.72	.75	.75
Phthalic anhydride	Lb.	.37	.37	.35	.36	.35	.35	.35	.35	.35	.35	.37	.40
Salicylic acid, tech	Lb.	.20	.18	.23	.23½	.25	.25	.23	.25	.25	.29	.35	.35
Alpha naphthylamine	Lb.	.28	.28	.30	.30	.30	.30	.28	.28	.28	.29	.28	.28
Aniline oil	Lb.	.17½	.17	.16½	.16	.15½	.14	.14	.14	.15	.16	.16	.16½
Aniline salt	Lb.	.25	.24	.24	.24	.22	.22	.22	.22	.22	.22	.22	.24
Anthracene, 80%	Lb.	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
Benzaldehyde, U.S.P.	Lb.	1.35	1.30	1.25	1.25	1.25	1.25	1.25	1.30	1.25	1.25	1.25	1.35
Benzoate of soda, U.S.P.	Lb.	.52	.55	.55	.55	.50	.50	.53	.53	.57	.57	.57	.57
Benzidine, base	Lb.	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85
Benzidine, sulphate	Lb.	.75	.75	.75	.75	.75	.80	.80	.80	.80	.80	.75	.75
Beta naphthol, tech	Lb.	.31	.29	.28	.27	.25	.23	.23	.22	.23	.23	.25	.25
Dichlorbenzene	Lb.	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.07	.07
Dinitrobenzene	Lb.	.21	.21	.23	.23	.22	.22	.20	.20	.20	.20	.20	.20
Diethylaniline	Lb.	.90	.95	1.15	.85	.65	.65	.65	.65	.50	.50	.50	.50
Dimethylaniline	Lb.	.40	.41	.38	.38	.37	.36	.36	.32	.32	.32	.39	.39
Dinitrophenol	Lb.	.38	.35	.33	.33	.33	.33	.33	.32	.32	.32	.32	.34
Diphenylamine	Lb.	.60	.60	.59	.59	.59	.59	.55	.54	.54	.54	.54	.54
Naphthalene, flake	Lb.	.07	.06½	.06½	.06½	.06½	.06½	.06½	.06½	.06½	.06½	.06	.06
Naphthalene, ball	Lb.	.08	.07½	.08	.08	.08	.08	.07½	.07½	.07½	.07½	.06½	.06½
Nitrobenzene	Lb.	.10½	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10
Ortho-nitro-toluene	Lb.	.15	.15	.12	.12	.12	.10	.10	.10	.10	.12	.10	.12
Para-phenylenediamine	Lb.	1.60	1.55	1.50	1.50	1.55	1.55	1.55	1.55	1.55	1.55	1.50	1.50
Para-amidophenol, base	Lb.	1.25	1.25	1.25	1.25	1.25	1.25	1.30	1.20	1.20	1.20	1.20	1.15
Para-amidophenol, HCl	Lb.	1.45	1.35	1.30	1.30	1.30	1.30	1.35	1.25	1.25	1.25	1.25	1.20
Para-dichlorbenzene	Lb.	.16½	.17	.15	.15	.13½	.17	.17	.17	.17	.17	.17	.17
Paranitraniline	Lb.	.77	.77	.75	.75	.75	.73	.72	.72	.72	.72	.72	.75
Phenol, U.S.P.	Lb.	.11½	.12	.11½	.12½	.14	.14	.15	.23	.35	.35	.34	.34
Resorcinol, tech	Lb.	1.45	1.30	1.30	1.30	1.30	1.30	1.30	1.50	1.50	1.50	1.50	1.50
Toluidine, mixed	Lb.	.32	.32	.32	.30	.30	.30	.30	.30	.30	.30	.30	.30

PRICES OF PRINCIPAL VEGETABLE OILS BY MONTHS, JANUARY–DECEMBER, 1922

Castor oil, AA, in bbls.	Lb.	$0.11½	$0.11½	$0.11½	$0.11½	$0.12	$0.12	$0.12	$0.13	$0.12½	$0.12½	$0.12½	$0.12½
China wood oil, in bbls.	Lb.	.13½	.14½	.14½	.13½	.13½	.13½	.12½	.12½	.12½	.12½	.12½	.12½
Coconut oil, Ceylon grade in bbls.	Lb.	.09	.08½	.09	.08½	.08½	.08½	.08½	.08½	.08½	.08½	.08½	.08½
Corn oil, crude, in bbls.	Lb.	.08½	.08½	.11	.11	.11½	.11½	.11	.10½	.10	.09	.09	.10½
Cottonseed oil, crude tank cars, f.o.b. mill	Lb.	.07	.08½	.10	.09½	.10	.10	.09½	.08½	.07½	.07½	.08½	.09
Cottonseed oil, summer yellow	Lb.	.09	.09½	.11½	.12	.12	.11½	.11	.10½	.11	.11½	.10½	.10
Linseed oil, raw, in bbl., domestic	Gal.	.70	.83	.81	.84	.87	.82	.89	.87	.88	.90	.86	.90
Palm oil, lagos	Lb.	.08	.08	.08	.07½	.07½	.07½	.07	.06½	.06½	.07	.07½	.07½
Peanut oil, crude, tank cars, f.o.b. mill	Lb.	.07½	.08½	.10	.09½	.10	.10	.09½	.09¼	.08½	.08½	.10	.12
Rapeseed oil, refined, in bbls.	Lb.	.82½	.84	.85	.84	.83	.84	.82	.82	.79	.78	.77	.79
Soya bean oil, in bbls., N. Y.	Lb.	.08½	.09	.10½	.10½	.11½	.12½	.12	.11½	.11½	.11½	.11	.11½

Coal-Tar Products and Vegetable Oils in 1922

The coal-tar products market has shown practically the same features as the chemical market. All basic commodities, such as benzol, cresylic acid, phenol and toluol, have shown exceptional strength and materially affected the otherwise quiet intermediate market. Although producers of crudes have not advanced prices to any noticeable extent, a pronounced scarcity has existed throughout the year at the works and second hands have demanded a premium on any spot material. Cresylic acid is quoted at 60c. per gal. for future delivery. Resale material, on the other hand, has brought as high as $1 per lb. Aniline oil and beta naphthol have completely recovered from their recent slump and producers have reported a satisfactory volume of business during the past 2 months. Phenol was quoted at 12c. per lb. during the early part of the year and steadily advanced to 34c. per lb. at the close. Producers reported a completely sold up market at the works since August and very little relief seems to be in sight for the early part of 1923.

Conditions in the market during the last quarter seemed quite satisfactory to leading dealers. Prices for most commodities were at higher levels at the close of the year than at any time during 1922. Cottonseed oil was quoted at 7c. per lb. in January and advanced to 9c. per lb. in December. All indications point to a higher market for 1923. Linseed oil recorded a gain of 20c. per gal. for the year. Prices early in the year were quoted at 70c. per gal. and gradually advanced to 90c.

The Other Side of the Ledger

In a recent editorial in the *Nation's Business* it has been pointed out that even in the boom year of 1920 not all corporative enterprises were successful. In fact, a large proportion of them showed no net income at all, according to the income tax statistics which have just been published by the Treasury Department. Ten thousand firms were "in the red." Of the corporations producing chemical and allied products, 47 per cent showed no income. This proportion was exceeded by only two industries—namely, mining and quarrying, with 60 per cent, and rubber and rubber goods with 58 per cent.

The proportion of corporations showing no net income for the year 1920 follows:

Industry	Per Cent
Mining and quarrying	60
Rubber and rubber goods	58
Chemical and allied products	47
Textiles and products	45
Food products, liquor and tobacco	45
Leather and products	43
Transportation and other public utilities	37
Trade	34
Metal and metal products	33
Public service, professional amusements, hotels, etc.	32
Finance, banking and insurance	30
Construction	30
Stone, clay and glass	27
Lumber and wood products	27
Printing and publishing	21
Paper, pulp and products	20

Steel Market Ends Year in Good Condition

Price Situation Better Than Was Expected a Few Months Ago—Mills Sustaining Production

PITTSBURGH, Dec. 29, 1922.

While it would be extravagant to say that the steel market is ending the year in a blaze of glory, it is ending it much better than was expected. An outstanding feature of the general condition, indeed, is that a rather large volume of business is being put through with a minimum of excitement. Orders are placed smoothly and easily, one mill or another being able to arrange the delivery desired provided the buyer is willing to pay the full market price. The business that fails to go through is the business the buyer expects to place at a price concession. The market presents a strong contrast with that of the summer and early autumn in that excitement is lacking, but the volume of tonnage is not to be judged by such appearances. The mills are quietly filling up. Some will soon be completely filled for first quarter, while others, which 2 months ago seemed likely to be unable to maintain production even to the end of the year, are now in comfortable position and with several weeks of full operation already assured.

The market is in much better condition than was expected a month or two months ago. It is more or less customary for buyers to ask mills to discontinue or decrease shipments in December, to lighten the work of inventory taking, but no such disposition has been exhibited this year. Only in very occasional instances have mills decreased production in the past month, although there are some cases of departments being closed for repairs.

PRICE SITUATION STRONG

The price situation is correspondingly strong and is better than was expected. Bars, shapes and plates were expected by many observers to be lower by this time, even 1.75c. having been mentioned a couple of months ago as a possibility. Instead, the regular 2c. price is more strictly observed than was the case in November. The market may indeed be described as firm at that level. Some large consumers have been expecting a concession on their first quarter requirements, but have been offered nothing outside of the regular price, and it is now hinted they may not receive full supplies if they delay further in placing their commitments.

In the sheet market the reports current 3 weeks ago of two or three mills making slight concessions from the regular price have disappeared. The market seems to be very firm on the basis of 3.35c., for common black, with galvanized at 4.35c. and blue annealed at 2.50c. The announcement of the Brier Hill Steel Co. of an advance in its price from 3.35c. to 3.50c. is now, however, taken seriously by other sellers. Incidentally, arrangements have been practically concluded whereby the Youngstown Sheet & Tube Co. will absorb this interest. Special finish sheets have been in particular demand, and of all the sheet mills, those that make special finish sheet mills have the larger order books. According to delivery and other conditions automobile sheets are bringing 4.70c., 4.85c. and 5c.

Tin plate is moving in a moderate way, with little contracting for the half year but with heavy buying in specific orders for the early months. The regular price of $4.75 is being generally observed. Many independent producers had expected the Steel Corporation to make an advance in naming its prices for the new period. Predictions in the trade are that domestic consumption in 1923 will be very large, stocks of canned goods being quite moderate. On the whole, domestic consumption in the past year was probably well ahead of that in any previous year. Production was about 1,400,000 gross tons, against 1,512,000 tons in the record year, 1917, but exports were much lighter.

Demand for tubular goods continues heavy. The open weather has helped building operations as well as work in the oil fields. The National Tube Co. has most of its finishing departments closed this week for necessary repairs, but is maintaining steel production as far as possible. It has just purchased 10,000 tons of bessemer billets from a Pittsburgh independent at $36.50 Pittsburgh, the regular market, to supplement its regular supplies in making butt weld pipe.

Demand for wire products continues heavy, with some producers sold as far ahead as they usually care to sell. Prices are firm on the basis of 2.45c. for plain wire and $2.70 for nails.

COKE AND PIG IRON

Foundry pig iron at valley furnace has advanced another dollar a ton, being firm now at $27 furnace, while the first quarter buying movement, early in December, was at $25. There was more iron bought on that movement than furnaces expected to sell when they made the price offer. All producers of foundry iron seem to be in comfortable position as to sales, while some are probably not in comfortable position as to coke supplies, since the advancing market of the past fortnight, due to purchasers for domestic consumption, has produced prices quite out of line with pig iron prices. Basic iron has not responded to the general stiffening tendency to any great extent, probably because there are several steel works willing to sell iron, but the market seems to be at about $25 valley, which compares with a few sales made recently at about $24.25. Bessemer is quiet at $27.50.

Buying of Connellsville coke by Eastern distributers for domestic use has been lighter in the past week, simply because there is no longer much coke to be picked up. Some domestic demand from the West has developed this week. The market is quotable at $9@$9.50, rather irrespective of grade, an advance of $2.50 to $3, from the recent minimum.

Current Prices in the New York Market

FOR CHEMICALS, OILS AND ALLIED PRODUCTS

Although these prices are for the spot market in New York City, a special effort has been made to report the American manufacturer's quotations whenever available. In many instances these are for material f.o.b. works or on a contract basis and these prices are so designated. Quotations on imported and resale stocks are reported when of sufficient importance to have a material effect on the market. Prices quoted in these columns apply to large quantities in original packages.

General Chemicals

Acetic anhydride, 85%, drums	lb.	$0.39 –	$0.41
Acetone, drums	lb.	.21 –	.21½
Acid, acetic, 28%, barrels, 100	lb.	3.50 –	3.60
Acetic, 56%, barrels, 100	lb.	7.00 –	7.15
Acetic, glacial, 99½%, carboys, 100	lb.	12.80 –	13.25
Boric, crystals, barrels	lb.	.11½–	.11¾
Boric, powder, barrels	lb.	.11 –	.11½
Citric, kegs	lb.	.49 –	.50
Formic, 85%	lb.	.18 –	.19
Gallic, tech.	lb.	.45 –	.50
Hydrochloric, 18 deg., tanks 100	lb.	.80 –	1.00
Hydrofluoric, 52%, carboys	lb.	.11 –	.11½
Lactic, 44% tech., light, barrels	lb.	.11 –	.11¼
Lactic, 22% tech., light, barrels	lb.	.05 –	.05½
Muriatic, 20 deg., tanks, 100	lb.	1.00 –	1.10
Nitric, 36 deg., carboys	lb.	.04½–	.05
Nitric, 42 deg., carboys	lb.	.06 –	.06¼
Oleum, 20%, tanks	ton	17.00 –	18.00
Oxalic, crystals, barrels	lb.	.13½–	.13¾
Phosphoric, 50% carboys	lb.	.07½–	.08
Pyrogallic, resublimed	lb.	1.50 –	1.60
Sulphuric, 60 deg., tanks	ton	9.00 –	10.00
Sulphuric, 60 deg., drums	ton	12.00 –	14.00
Sulphuric, 66 deg., tanks	ton	14.50 –	15.00
Sulphuric, 66 deg., drums	ton	19.00 –	20.00
Tannic, U.S.P., barrels	lb.	.65 –	.70
Tannic, (tech.), barrels	lb.	.40 –	.45
Tartaric, imported crys., barrels	lb.	.30½–	.31
Tartaric, imported, powd., barrels	lb.	.31 –	.32
Tartaric, domestic, barrels	lb.	..... –	.32
Tungstic, per pound of WO	lb.	1.00 –	1.20
Alcohol, butyl, drums	gal.	.18 –	.23
Alcohol, ethyl (Cologne spirit), barrels	gal.	4.75 –	4.95
Alcohol, methyl, 95%, barrels	gal.	1.23 –	1.25
Alcohol, methyl, 97%, barrels	gal.	1.25 –	1.27
Alcohol, denatured, 188 proof No. 1	gal.	.39 –	.41
Alcohol, denatured, 188 proof No. 5	gal.	.38 –	.40
Alum, ammonia, lump, barrels	lb.	.03½–	.03¾
Alum, potash, lump, barrels	lb.	.03½–	.03¾
Alum, chrome, lump, potash, barrels	lb.	.05 –	.05¼
Aluminum sulphate, com., bags 100	lb.	1.50 –	1.65
Aluminum sulphate, iron free, bags	lb.	.02½–	.02¾
Aqua ammonia, 26 deg., drums	lb.	.06¾ –	.07½
Ammonia, anhydrous, cyl.	lb.	.3 –	.30½
Ammonium carbonate, powd. casks	lb.	.09 –	.09½
Ammonium nitrate, tech., casks	lb.	.07½–	.07½
Amylacetate tech., drums	gal.	2.80 –	3.05
Arsenic, white, powd., barrels	lb.	.16 –	.16½
Arsenic, red, powd., kegs	lb.	.13½–	.14
Barium carbonate, barrels	ton	75.00 –	77.00
Barium chloride, barrels	ton	94.00 –	100.00
Barium dioxide, drums	lb.	.18 –	.18½
Barium nitrate, casks		.08½–	.08¾
Barium sulphate, barrels	lb.	.04 –	.04½
Blanc fixe, dry, barrels	lb.	.04 –	.04½
Blanc fixe, pulp, barrels	ton	45.00 –	55.00
Bleaching powder, f.o.b. wks, drums 100	lb.	2.00 –	2.50
Bleaching powder, drums, resale 100	lb.	2.25 –	2.50
Borax, barrels	lb.	.05½–	.05¾
Bromine, cases	lb.	.27 –	.28
Calcium acetate, bags 100	lb.	3.50 –	3.60
Calcium carbide, drums	lb.	.04½–	.04¾
Calcium chloride, fused, drums	ton	22.00 –	23.00
Calcium chloride, gran., drums	lb.	.01½–	.01¾
Calcium phosphate, mono., barrels	lb.	.06½–	.07
Camphor, cases	lb.	.95 –	.96
Carbon bisulphide, drums	lb.	.07 –	.07½
Carbon tetrachloride, drums	lb.	.10 –	.10½
Chalk, precip.—domestic, light, barrels	lb.	.04½–	.04¾
Chalk, precip.—domestic, heavy, barrels	lb.	.03½–	.03¾
Chalk, precip.—imported, light, barrels	lb.	$.04½–	$.05
Chlorine, liquid-cylinders	lb.	.06 –	.06½
Chloroform, tech. drums	lb.	.35 –	.38
Cobalt oxide, barrels	lb.	2.10 –	2.25
Copperas, bulk, f.o.b. wks	ton	20.00 –	22.00
Copper carbonate, barrels	lb.	.20 –	.20½
Copper cyanide, drums	lb.	.50 –	.55
Copper sulphate, crystals, barrels 100	lb.	6.00 –	6.25
Cream of tartar, barrels	lb.	.25 –	.26
Dextrine, corn, bags	lb.	.....–	.....
Epsom salt, domestic, tech., barrels 100	lb.	2.10 –	2.25
Epsom salt, imported, tech., bags 100	lb.	1.10 –	1.25
Epsom salt, U.S.P., domestic, barrels 100	lb.	2.50 –	2.75
Ether, U.S.P., drums	lb.	.13 –	.15
Ethyl acetate, com. 85%, drums	gal.	.80 –	.85
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	.95 –	1.00
Formaldehyde, 40%, barrels	lb.	.16 –	.16½
Fullers earth, f.o.b. mines net	ton	16.00 –	17.00
Fullers earth—imported powd. net	ton	30.00 –	32.00
Fusel oil, ref., drums	gal.	3.55 –	4.05
Fusel oil, crude, drums	gal.	2.30 –	2.40
Glauber's salt, f.o.b. wks, bags 100	lb.	1.20 –	1.40
Glauber's salt, impt., bags 100	lb.	1.00 –	1.25
Glycerine, c.p. drums extra	lb.	.18 –	.19
Glycerine, dynamite, drums	lb.	.16 –	.17
Iodine, resublimed	lb.	4.50 –	4.60
Iron oxide, red, casks	lb.	.12 –	.18
Lead—			
White, basic carbonate, dry, casks	lb.	.08 –	.08¾
White, in oil, kegs	lb.	.10½–	.12
Red, dry, casks	lb.	.10½–	.10¾
Red, in oil, kegs	lb.	.12 –	.14
Lead acetate, white crystals, barrels	lb.	.12 –	.12½
Lead arsenate, powd., barrels	lb.	.21 –	.22
Litharge, comm., casks	lb.	.09½–	.10
Lithophone, barrels	lb.	.06½–	.06¾
Magnesium carbonate, tech. bags	lb.	.07 –	.07½
Nickel salt, double, barrels	lb.	.10 –	.10½
Nickel salts, single, barrels	lb.	.11 –	.11½
Phosgene		.60 –	.75
Phosphorus, red, cases	lb.	.35 –	.40
Phosphorus, yellow, cases	lb.	.30 –	.35
Potassium bichromate, casks	lb.	.09½–	.10
Potassium bromide, granular, barrels	lb.	.18 –	.25
Potassium carbonate, 80-85%, calcined, casks	lb.	.05½–	.05¾
Potassium chlorate, powd.	lb.	.07½–	.08
Potassium cyanide, drums	lb.	.47 –	.50
Potassium hydroxide, (caustic potash) drums 100	lb.	6.25 –	6.50
Potassium iodide, cases	lb.	3.55 –	3.65
Potassium nitrate, barrels	lb.	.06½–	.06¾
Potassium permanganate, drums	lb.	.16 –	.16½
Potassium prussiate, red, casks	lb.	.92 –	.95
Potassium prussiate, yellow, casks	lb.	.38 –	.39
Salammoniac, white, gran., casks	lb.	.06½–	.06¾
Salammoniac, gray, gran., casks	lb.	.08 –	.08½
Salsoda, barrels 100	lb.	1.20 –	1.40
Salt cake (bulk)	ton	25.00 –	27.00
Soda ash, light, 58% flat, bags, contract 100	lb.	1.60 –	1.67
Soda ash, light, basis, 48%, bags, contract, f.o.b. wks, 100	lb.	1.20 –	1.30
Soda ash, light, 58%, flat, bags, resale 100	lb.	1.75 –	1.80
Soda ash, dense, bags, contract, basis 48% 100	lb.	1.17½–	1.20
Soda ash, dense, in bags, resale 100	lb.	1.85 –	1.90
Caustic soda, 76%, solid, drums, f.a.s. 100	lb.	3.50 –	3.75
Caustic soda, 76%, solid, drums, contract 100	lb.	3.35 –	3.40
Caustic soda, basis 60%, wks., contract 100	lb.	$2.50 –	$2.60
Caustic soda, ground and flake, contracts 100	lb.	3.80 –	3.90
Caustic soda, ground and flake, resale 100	lb.	$4.00 –	$4.15
Sodium acetate, works, bags	lb.	.07½–	.07¾
Sodium bicarbonate, barrels, 100	lb.	1.75 –	1.85
Sodium bichromate, casks	lb.	.07½–	.07¾
Sodium bisulphate (niter cake)	ton	6.00 –	7.00
Sodium bisulphite, powd., U.S.P., barrels	lb.	.04½–	.04¾
Sodium chlorate, kegs	lb.	.06 –	.07
Sodium chloride long	ton	12.00 –	13.00
Sodium cyanide, cases	lb.	.19½–	.23
Sodium fluoride, barrels	lb.	.09 –	.09½
Sodium hyposulphite, barrels	lb.	.03 –	.03¼
Sodium nitrite, casks	lb.	.08½–	.09
Sodium peroxide, powd., cases	lb.	.28 –	.30
Sodium phosphate dibasic, barrels	lb.	.03½–	.04
Sodium prussiate, yellow, drums	lb.	.19 –	.20
Sodium silicate (40 deg. drums) 100	lb.	1.25 –	1.30
Sodium silicate (60 deg. drums) 100	lb.	2.25 –	2.40
Sodium sulphide, fused, 60-62%, drums	lb.	.04½–	.04¾
Sodium sulphite, crys., barrels	lb.	.03½–	.03¾
Strontium nitrate, powd., barrels	lb.	.09½–	.10
Sulphur chloride, yellow drums	lb.	.04½–	.05
Sulphur, crude	ton	18.00 –	20.00
Sulphur dioxide, liquid, cyl.	lb.	.08 –	.08½
Sulphur, flour, barrels 100	lb.	2.50 –	3.15
Sulphur, roll, barrels 100	lb.	2.15 –	2.20
Talc—imported, bags	ton	30.00 –	40.00
Talc—domestic powd., bags	ton	18.00 –	25.00
Tin bichloride, barrels	lb.	.10½–	.10¾
Tin oxide, barrels	lb.	.45 –	.47
Zinc carbonate, bags	lb.	.14 –	.14½
Zinc chloride, gran, barrels	lb.	.07 –	.07½
Zinc cyanide, drums	lb.	.42 –	.44
Zinc oxide, XX, barrels	lb.	.07½–	.08
Zinc sulphate, barrels 100	lb.	2.75 –	3.00

Coal-Tar Products

Alpha-naphthol, crude, barrels	lb.	0.95 –	1.00
Alpha naphthol, ref., barrels	lb.	1.05 –	1.10
Alpha-naphthylamine, bbl	lb.	.28 –	.30
Aniline oil, drums	lb.	.16½–	.17
Aniline salts, barrels	lb.	.24 –	.25
Anthracene, 80%, drums	lb.	.75 –	1.00
Anthracene, 80%, imp. drums, duty paid	lb.	.65 –	.70
Anthraquinone, 25%, paste, drums	lb.	.70 –	.75
Benzaldehyde U.S.P. carboys	lb.	1.35 –	1.40
Benzene, pure, water-white, drums	gal.	.30 –	.35
Benzene, 90%, drums	gal.	.28 –	.32
Benzene, 90%, drums, resale	gal.	.37 –	.40
Benzidine base, barrels	lb.	.85 –	.90
Benzidine sulphate, barrels	lb.	.75 –	.80
Benzoic acid, U.S.P., kegs	lb.	.70 –	.75
Benzoate of soda, U.S.P., barrels	lb.	.57 –	.65
Benzyl chloride, 95-97%, ref., drums	lb.	.25 –	.27
Benzyl chloride, tech., drums	lb.	.20 –	.23
Beta-naphthol, sublimed, barrels	lb.	.55 –	.60
Beta-naphthol, tech., barrels	lb.	.25 –	.26
Beta-naphthylamine, tech	lb.	1.00 –	1.25
Carbazol, barrels	lb.	.75 –	.90
Cresol, U.S.P., drums	lb.	.14 –	.20
Ortho-cresol, drums	lb.	.18 –	.22
Cresylic acid, 97-99%, drums	gal.	.60 –	.65
Cresylic acid, 95-97%, drums	gal.	.55 –	.58
Cresylic acid, 97%, resale, drums	gal.	1.00 –	1.05
Dichlorbenzene, drums	lb.	.07 –	.09
Diethylaniline, drums	lb.	.50 –	.60
Dimethylaniline, drums	lb.	.39 –	.41
Dinitrobenzene, barrels	lb.	.20 –	.22
Dinitroclorbenzene, barrels	lb.	.22 –	.23
Dinitronaphthalene, barrels	lb.	.3[illegible]	.32

Dinitrophenol, barrels	lb.	$.34 –	$.36
Dinitrotoluene, barrels	lb.	.22 –	.24
Dip oil, 25%, drums	gal.	.25 –	.30
Diphenylamine, barrels	lb.	.54 –	.56
H-acid, barrels	lb.	.75 –	.80
Meta-phenylenediamine, barrels	lb.	.95 –	1.00
Michlers ketone, barrels	lb.	3.75 –	3.85
Monochlorbenzene, drums	lb.	.08 –	.10
Monoethylaniline, drums	lb.	.95 –	1.10
Naphthalene crushed, barrels	lb.	.05½–	.06
Naphthalene, flake, barrels	lb.	.06 –	.06½
Naphthalene, balls, barrels	lb.	.06½–	.07
Naphthionate of soda, barrels	lb.	.58 –	.65
Naphthionic acid, crude, barrels	lb.	.60 –	.65
Nitrobenzene, drums	lb.	.10 –	.12
Nitro-naphthalene, barrels	lb.	.30 –	.35
Nitro-toluene, drums	lb.	.15 –	.17
N-W acid, barrels	lb.	1.20 –	1.30
Ortho-amidophenol, kegs	lb.	2.25 –	2.30
Ortho-dichlor-benzene, drums	lb.	.17 –	.20
Ortho-nitro-phenol, barrels	lb.	.85 –	.90
Ortho-nitro-toluene, drums	lb.	.12½–	.14
Ortho-toluidine, barrels	lb.	.14 –	.16
Para-amidophenol, base, kegs	lb.	1.15 –	1.20
Para-amidophenol, HCl, kegs	lb.	1.20 –	1.25
Para-dichlorbenzene, barrels	lb.	.17 –	.20
Paranitroaniline, barrels	lb.	.75 –	.80
Para-nitrotoluene, barrels	lb.	.55 –	.65
Para-phenylenediamine, barrels	lb.	1.50 –	1.55
Para-toluidine, barrels	lb.	.85 –	.90
Phthalic anhydride, barrels	lb.	.40 –	.50
Phenol, U.S.P., drums	lb.	.34 –	.35
Picric acid, barrels	lb.	.20 –	.22
Pyridine, domestic, drums	gal.	1.60 –	1.75
Pyridine, imported, drums	gal.	1.40 –	1.60
Resorcinol, tech., kegs	lb.	1.50 –	1.55
Resorcinol, pure, kegs	lb.	2.00 –	2.10
R-salt, barrels	lb.	.55 –	.60
Salicylic acid, tech., barrels	lb.	.35 –	.37
Salicylic acid, U.S.P., barrels	lb.	.40 –	.42
Solvent naphtha, water-white, drums	gal.	.37 –	.40
Solvent naphtha, crude, drums	gal.	.22 –	.24
Sulphanilic acid, crude, barrels	lb.	.20 –	.22
Thiocarbanilide, kegs	lb.	.35 –	.38
Tolidine, kegs	lb.	1.20 –	1.30
Toluidine, mixed, kegs	lb.	.30 –	.35
Toluene, tank cars	gal.	.35 –	.37
Toluene, drums	gal.	.40 –	.43
Xylidines, drums	lb.	.40 –	.45
Xylene, pure, drums	gal.	.45 –	.50
Xylene, pure, tanks	gal.	.45 –	.....
Xylene, com., drums	gal.	.40 –	.42
Xylene, com., tanks	gal.	.30 –	.....

Naval Stores

Rosin B-D, barrel 280 lb.		$6.10 –	.....
Rosin E-I, barrels 280 lb.		6.20 –	.....
Rosin K-N, barrels 280 lb.		6.30 –	$6.85
Rosin W.G.-W.W., barrels 280 lb.		7.75 –	8.25
Wood rosin, barrels 280 lb.		6.25	
Spirits of turpentine, barrels	gal.	1.36 –	1.37
Wood turpentine, steam dist., barrels	gal.	1.35 –	.....
Wood turpentine, dest. dist., barrels	gal.	1.25 –	.....
Pine tar pitch, barrels 200 lb.		..... –	6.00
Tar, kiln burned, barrels (500 pound)	bbl.	..... –	12.50
Retort tar, barrels 500 lb.		..... –	11.00
Rosin oil, first run, barrels	gal.	.43 –	.....
Rosin oil, second run, barrels	gal.	.51 –	.....
Rosin oil, third run, barrels	gal.	.53 –	.....
Pine oil, steam dist.	gal.	..... –	.90
Pine oil, pure, dest. dist.	gal.	..... –	.85
Pine tar oil, ref.	gal.	..... –	.46
Pine tar oil, crude, tanks f.o.b. Jacksonville, Fla.	gal.	..... –	.35
Pine tar oil, double ref., barrels	gal.	..... –	.75
Pine tar, ref., thin, barrels	gal.	..... –	.25
Pinewood creosote, ref., barrels	gal.	..... –	.52

Vegetable Oils

Castor oil, No. 3, barrels	lb.	$0.12 –	$0.12½
Castor oil, AA, barrels	lb.	.12½–	.13
China wood oil, barrels	lb.	.12½–	.12½
Coconut oil, Ceylon grade, barrels	lb.	.08½–	.08½
Coconut oil, Cochin grade, barrels	lb.	.09 –	.09½
Corn oil, crude, barrels	lb.	.10½–	.10½
Cottonseed oil, crude (f.o.b. mill), tanks	lb.	.09 –	.....
Cottonseed oil, summer yellow, barrels	lb.	.10½–	.11
Cottonseed oil, winter yellow, barrels	lb.	.11 –	.11½
Linseed oil, raw, car lots (domestic), barrels	gal.	.90 –	.91
Linseed oil, raw, tank cars (domestic)	gal.	.86 –	.87
Linseed oil, boiled, 5-barrel lots (domestic)	gal.	.92 –	.93
Olive oil, denatured, barrels	gal.	1.05 –	1.12
Palm, Lagos, casks	lb.	.07½–	.07½
Palm kernel, barrels	lb.	.08 –	.08½
Peanut oil, crude, tanks (f.o.b. mill)	lb.	.12 –	.12½
Peanut oil, refined, barrels	lb.	.13½–	.14
Rapeseed oil, refined, barrels	gal.	.79 –	.80
Rapeseed oil, blown, barrels	gal.	.86 –	.87
Soya bean oil (Manchurian), barrels	lb.	.11½–	.....
Soya bean oil, tank, f.o.b., Pacific coast	lb.	.09½–	.09½

Fish Oils

Light pressed menhaden, barrels	gal.	$0.60 –	.....
White bleached menhaden, barrels	gal.	.64 –	.65
Blown menhaden, barrels	gal.	.68 –	.69
Whale Oil No. 1 crude, tanks, coast	lb.	.06 –	.06½

Dye & Tanning Materials

Divi-divi, bags	ton	$38.00 –	$39.00
Fustic, sticks	ton	30.00 –	35.00
Fustic, chips, bags	lb.	.04 –	.05
Logwood, sticks	ton	28.00 –	30.00
Logwood, chips, bags	lb.	.02½–	.03½
Sumac, leaves, Sicily, bags	ton	65.00 –	.....
Sumac, ground, bags	ton	55.00 –	60.00
Sumac, domestic, bags	ton	35.00 –	.....
Tapioca flour, bags	lb.	.03½–	.05

Extracts

Archil, conc., barrels	lb.	$0.18 –	$0.20
Chestnut, 25% tannin, tanks	lb.	.02 –	.03
Divi-divi, 25% tannin, barrels	lb.	.04 –	.05
Fustic, crystals, barrels	lb.	.20 –	.22
Fustic, liquid, 42 deg., barrels	lb.	.08 –	.09
Gambier, liquid, 25% tannin, barrels	lb.	.08 –	.09
Hematine crystals, barrels	lb.	.14 –	.18
Hemlock, 25% tannin, barrels	lb.	.04 –	.05
Hypernic, solid, drums	lb.	.24 –	.26
Hypernic, liquid, 51 deg., barrels	lb.	.14 –	.17
Logwood, crystals, barrels	lb.	.19 –	.20
Logwood, liquid, 51 deg., barrels	lb.	.09 –	.10
Quebracho, solid, 65% tannin, barrels	lb.	.04½–	.05
Sumac, domestic, 51 deg., barrels	lb.	.06½–	.07

Waxes

Bayberry, barrels	lb.	$0.28 –	$0.30
Beeswax, refined, dark, bags	lb.	.30 –	.32
Beeswax, refined, light, bags	lb.	.34 –	.35
Beeswax, pure white, cases	lb.	.39 –	.40
Candellila, bags	lb.	.34 –	.35
Carnauba, No. 1, bags	lb.	.39 –	.40
Carnauba No. 2, North Country, bags	lb.	.23 –	.24
Carnauba, No. 3, North Country, bags	lb.	.17½–	.18
Japan, cases	lb.	.15 –	.15½
Montan, crude, bags	lb.	.03½–	.04
Paraffine, crude, match, 105-110 m.p	lb.	.04 –	.04½
Paraffine, crude, scale 124-126 m.p., bags	lb.	.02½–	.02¾
Paraffine ref., 118-120 m.p., bags	lb.	.03½–	.03¾
Paraffine, ref., 125 m.p., bags	lb.	.03¾–	.03¾
Paraffine, ref., 128-130 m.p., bags	lb.	.04 –	.04¼
Paraffine, ref., 133-135 m.p., bags	lb.	.04¼–	.04¼
Paraffine, ref., 135-137 m.p., bags	lb.	.05 –	.05¼
Stearic acid, single pressed, bags	lb.	.10 –	.10¼
Stearic acid, double pressed, bags	lb.	.10¼–	.10¼
Stearic acid, triple pressed, bags	lb.	.11 –	.11¼

Fertilizers

Ammonium sulphate, bulk, f.o.b. works 100 lb.		$3.20 –	$3.25
Ammonium sulphate, f.a.s., N. Y., double bags 100 lb.		3.65 –	3.75
Blood, dried, f.o.b., N. Y., bulk	unit	4.60 –	.....
Bone, 3 and 50, ground, raw, bulk	ton	30.00 –	35.00
Fish scrap, dom., dried, f.o.b. works	unit	5.00 –	5.10
Nitrate of soda, bags 100 lb.		2.57½–	2.60
Tankage, high grade, f.o.b. Chicago	unit	4.60 –	4.65
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	3.50 –	4.00
Tennessee, 78-80%	ton	7.00 –	8.00
Potassium muriate, 80%, bags	ton	35.55 –	38.25
Potassium sulphate, bags	unit	1.00 –	.....

Crude Rubber

Para—Upriver fine	lb.	$0.25½–	.25½
Upriver coarse	lb.	.17½–	.17½
Upriver caucho ball	lb.	.20½–	.20½
Plantation—First latex crepe	lb.	.27½–	.27½
Ribbed smoked sheets	lb.	.27½–	.27½
Brown crepe, thin, clean	lb.	.23 –	.23½
Amber crepe No. 1	lb.	.23 –	.23½

Miscellaneous Materials

Asbestos, crude No. 1 f.o.b., Quebec short ton		$650.00 –	$700.00
Asbestos, shingle, f.o.b., Quebec short ton		60.00 –	80.00
Asbestos, cement, f.o.b., Quebec short ton		15.00 –	17.00
Barytes, ground, white, f.o.b. mills, barrels net ton		16.00 –	20.00
Barytes, ground, off color f.o.b. mills bulk net ton		13.00 –	21.00
Barytes, floated, f.o.b. St. Louis, barrels net ton		23.00 –	24.00
Barytes, crude f.o.b. mines, bulk net ton		8.00 –	9.00
Casein, barrels, tech.	lb.	.12 –	.14
China clay (kaolin) crude, f.o.b., Georgia net ton		6.00 –	8.00
China clay (kaolin) washed, f.o.b. Georgia bulk net ton		8.00 –	9.00
China clay (kaolin) powd., f.o.b. Georgia, bulk net ton		14.00 –	20.00
China clay (kaolin) crude f.o.b. Virginia net ton		8.00 –	12.00
China clay (kaolin) ground, f.o.b. Virginia net ton		13.00 –	20.00
China clay (kaolin), imp., lump, bulk net ton		14.00 –	20.00
China clay (kaolin), imp., powd., bulk net ton		40.00 –	45.00
Feldspar, No. 1 pottery grade, bulk long ton		5.50 –	7.00
Feldspar, No. 2 pottery grade, bulk long ton		4.00 –	5.50
Feldspar, No. 1 soap grade, bulk long ton		7.00 –	7.50
Feldspar, No. 1 Canadian, f.o.b. mill bulk long ton		20.00 –	21.00
Graphite, Ceylon lump, firs quality, f.o.b. N. Y., barrels	lb.	.05 –	.05½
Graphite, Ceylon chip, barrels	lb.	.04 –	.04½
Graphite, high grade amorphous crude, bulk ton		35.00 –	50.00
Gum Arabic, amber, sorts, bags	lb.	.15 –	.16
Gum tragacanth, sorts, bags	lb.	.50 –	.60
Gum tragacanth No. 1, bags	lb.	1.75 –	1.80
Kieselguhr, f.o.b., Cal., bulk ton		40.00 –	42.00
Kieselguhr, f.o.b. N. Y., bulk ton		50.00 –	55.00
Magnesite, crude, f.o.b. Cal., bulk ton		12.00 –	15.00
Pumice stone, imp., casks	lb.	.03 –	.05½
Pumice stone, dom., lump, barrels	lb.	.05 –	.05½
Pumice stone, dom., ground, barrels	lb.	.06 –	.07
Shellac, orange fine, bags	lb.	.74 –	.75
Shellac, orange superfine, bags	lb.	.76 –	.77
Shellac, A.C. garnet, bags	lb.	.75 –	.77
Shellac, T. N., bags	lb.	.72 –	.73
Silica, glass sand, f.o.b. Indiana, bulk ton		1.75 –	2.50
Silica, sand blast material, f.o.b. Indiana, bulk ton		2.50 –	5.00
Silica, amorphous, 250-mesh, f.o.b. Illinois, bulk ton		17.00 –	17.50
Silica, building sand, f.o.b. Pa., bulk ton		2.00 –	2.75
Soapstone, coarse, f.o.b. Vermont, bags ton		7.00 –	8.00
Talc, 200 mesh, f.o.b. Vermont, bags ton		7.00 –	12.00
Talc, 200 mesh, f.o.b. Georgia, bags ton		7.50 –	12.00
Talc, 200 mesh, f.o.b. Los Angeles, bags ton		15.00 –	17.00

Refractories

Bauxite brick, 56% Al_2O_3, f.o.b. Pittsburgh	ton	$45–50
Chrome brick, f.o.b. Eastern shipping points	ton	50
Chrome cement, 40-50% Cr_2O_3	ton	23–27
Chrome cement, 40-45% Cr_2O_3, sacks, f.o.b. Eastern shipping points	ton	23.00
Fireclay brick, 1st. quality, 9-in. shapes, f.o.b., Pa., Ohio and Kentucky works	1,000	43–46
Fireclay brick, 2nd. quality, 9-in. shapes, f.o.b. Pa., Ohio and Kentucky works	1,000	39–41
Magnesite brick, 9-in. straight (f.o.b. works)	ton	70–75
Magnesite brick, 9-in. arches, wedges and keys	ton	85–90
Magnesite brick, soaps and splits	ton	90
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	48–50

Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	$50–53
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	45–47
Silicon carbide refractory brick, 9-in.	1,000	1,100.00

Ferro-Alloys

Ferrotitanium, 15-18 %, f.o.b. Niagara Falls, N. Y.	ton	$200.00 –$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon	lb.	.11 – .11½
Ferrochromium, per lb. of Cr contained, 4-6% carbon	lb.	.11½– .12
Ferromanganese, 78-82% Mn, Atlantic seaboard duty paid	gross ton	100.00 – 105.00
Spiegeleisen, 19-21% Mn	gross ton	38.00 – 39.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 – 2.25
Ferrosilicon, 10-15%	gross ton	38.00 – 40.00
Ferrosilicon, 50%	gross ton	75.00 – 80.00
Ferrosilicon 75%	gross ton	115.00 – 120.00
Ferrotungsten, 70-80 % per lb. of contained W	lb.	.85 – .95
Ferro-uranium, 35-50 % of U, per lb. of U content	lb.	6.00 –
Ferrovanadium, 30-40 % per lb. of contained V	lb.	3.50 – 4.00

Ores and Semi-finished Products

Bauxite, domestic, crushed and dried, f.o.b. shipping points	ton	$6.00 – $9.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	22.00 – 23.00
Chrome ore, 50% Cr_2O_3, c.i.f. Atlantic seaboard	ton	18.50 – 19.00
Coke, foundry, f.o.b. ovens	ton	8.50 – 9.00
Coke, furnace, f.o.b. ovens	ton	8.50 – 9.00
Fluorspar, gravel, f.o.b. mines, New Mexico	ton	17.50 –
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	ton	$21.50 – $22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½– .01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.45 –
Manganese ore, chemical (MnO_2)	ton	75.00 – 80.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.70 – .75
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	lb.	.06 – .08
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.11½– .12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.11½– .12
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	Nominal
Rutile, 95% TiO_2 per lb. ore	lb.	.12 –
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	8.50 – 8.75
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	7.50 – 8.00
Uranium ore (carnotite) per lb. of U_3O_8	lb.	3.50 – 3.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 – 2.50
Vanadium pentoxide, 99%	lb.	12.00 – 14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 –
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½– .13½

Non-Ferrous Materials

	Cents per Lb.
Copper, electrolytic	14.65
Aluminum, 98 to 99%	22.00–23.00
Antimony, wholesale lots, Chinese and Japanese	6.35
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	32.00–33.00
Nickel, ingot and shot, resale	36.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	38.875
Lead, New York, spot	7.25
Lead, E. St. Louis, spot	7.05
Zinc, spot, New York	7.25–7.30
Zinc, spot, E. St. Louis	6.90–6.95

OTHER METALS

Silver (commercial)	oz.	$0.63½
Cadmium	lb.	1.15
Bismuth (500 lb. lots)	lb.	2.45
Cobalt	lb.	3.00@3.25
Magnesium, ingots, 99%	lb.	1.00@1.05
Platinum	oz.	$118.00
Iridium	oz.	240.00@275.00
Palladium	oz.	65.00
Mercury	75 lb.	72.50

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.00
Copper bottoms	30.00
Copper rods	19.75
High brass wire	18.75
High brass rods	16.75
Low brass wire	19.60
Low brass rods	20.25
Brazed brass tubing	23.00
Brazed bronze tubing	28.00
Seamless copper tubing	24.75
Seamless high brass tubing	22.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

Copper, heavy and crucible	11.00@11.25
Copper, heavy and wire	10.50@10.75
Copper, light and bottoms	8.50@8.75
Lead, heavy	4.50@4.75
Lead, tea	3.25@3.50
Brass, heavy	5.50@5.75
Brass, light	5.00@5.25
No. 1 yellow brass turnings	5.50@5.75
Zinc	2.25@2.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Chicago
Structural shapes	$2.90	$2.90
Soft steel bars	2.80	2.80
Soft steel bar shapes	2.80	2.80
Soft steel bands	3.40	3.40
Plates, ¼ to 1 in. thick	2.90	2.90

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

TUSCALOOSA—The Thress Brick Co., recently organized, has plans in progress for the construction of a new plant on local site, with initial capacity of about 60,000 bricks per day. A number of kilns, updraft type, will be constructed, with machinery installation to provide for a mechanical drying capacity of 600,000 bricks. The new plant is estimated to cost in excess of $50,000. J. H. Thress is vice-president and general manager.

TUSCUMBIA—W. T. Archer and Thurmond Harris, Tuscumbia, are planning for the organization of a company to construct and operate a cement mill and lime-manufacturing plant in the vicinity of the Keller quarry. The proposed works is estimated to cost about $200,000, with machinery.

BIRMINGHAM—The McWane Cast Iron Pipe Co. has filed plans and will commence the immediate construction of the first unit of its proposed new foundry, on site recently acquired at East Birmingham, to cost approximately $50,000. The plant will specialize in the production of small-sized cast-iron pipe.

California

LOS ANGELES—W. P. Fuller & Co., 135 North Los Angeles St., manufacturers of paints, varnishes, etc., have plans in progress for the erection of a new 5-story and basement building, 180x250 ft., on San Bernardino Road, near Barranca St., to be used in connection with its local works. Morgan, Walls & Morgan, Van Nuys Bldg., are architects. The company recently awarded a contract for a similar plant building on Ave. 22, 120x125 ft., to cost about $45,000.

PITTSBURG—The Columbia Steel Co. has plans in progress for the construction of a new 6-mill sheet rolling mill at its local plant. It is estimated to cost close to $200,000, and will be equipped with modern electrically operated machinery in the different departments.

SALINAS—The National Stone-Tile Co., San Francisco, has preliminary plans under way for the construction of a local plant for the manufacture of hollow cement brick and kindred products.

SAN BERNARDINO—The Shell Oil Co., 343 Sansome St., San Francisco, is negotiating for property at the foot of F St., near Rialto Ave., approximating 30,000 sq.ft., as a site for a new distributing and storage plant, estimated to cost about $80,000, with equipment.

Colorado

COLORADO SPRINGS—The Van Briggle Tile & Pottery Co. is completing plans for extensions in its plant, to include the construction of a new kiln, and the installation of additional equipment. I. F. and J. H. Lewis head the company.

Florida

EUSTIS—A. J. Wolz & Sons, operating a local plant for the manufacture of brick and kindred burned clay products, are planning for the installation of additional equipment for plant enlargement. A new kiln will be constructed.

Georgia

ATHENS—The Georgia Brick Co. has plans in progress for the rebuilding of the portion of its plant recently destroyed by fire, with loss estimated at about $40,000, including equipment. H. H. Hinton heads the company.

Illinois

CHICAGO—The Goldsmith Brothers Smelting & Refining Co., 29 East Madison St., has completed plans and will soon commence the construction of its proposed new plant at Throop and 58th Sts., comprising two 1-story buildings, estimated to cost close to $200,000, with equipment. Frank D. Chase, Inc., 645 North Michigan Ave., is architect and engineer.

MT. VERNON—The Bitumacite Coal Co., 37 West Van Buren St., Chicago, W. W. Ketchem, president, has completed plans for the construction of a new 1-story plant on local site, 50x100 ft., for the manufacture of fuel briquets, estimated to cost about $55,000, with equipment.

Indiana

SHELBYVILLE—The Kennedy Paper Co. is taking bids for the construction of its proposed 1-story plant addition, 50x130 ft., estimated to cost approximately $30,000. Work will be placed under way at an early date. Rubush & Hunter, American Central Life Bldg., Indianapolis, are architects.

Kentucky

MARION—The Big Four Fluorspar & Ore Co., Farmers' Bank Bldg., Pittsburgh, Pa., has plans under way for the construction of a local fluorspar mining and milling plant with initial capacity of about 75 tons per day. It is estimated to cost approximately $100,000, including machinery. A. H. Reed is local manager.

PROVIDENCE—The Island River Fluorspar Co., recently organized, is considering plans for the installation of a local mining and milling plant, estimated to cost approximately $75,000. The company is capitalized at $250,000, and is headed by S. K. Holland and Thomas O. Long.

BOWLING GREEN—The Rock Asphalt Co. of America, recently organized, has preliminary plans in progress for the installation and operation of a plant in this vicinity for the production of commercial asphalt. W. E. Massey, Louisville, is president.

Louisiana

BASTROP—The Bastrop Pulp & Paper Co. is planning for the installation of additional machinery at its plant, for the manufac-

ture of kraft papers, and will increase the output about 50 tons per day. Work has been commenced on a new 1-story power house.

MONROE—The Southern Carbon Co. is said to have plans under way for the construction of additional plant units to cost more than $1,000,000, with machinery.

Maryland

CAMBRIDGE—The Dorchester Lime & Fertilizer Co. will soon take bids for the construction of the first building at its local plant, to replace the structures recently destroyed by fire. It will cost about $30,000. Another building will be erected in the near future. Webster N. Andrews is general manager.

BALTIMORE—The Inter-Ocean Oil Co. is planning for the rebuilding of its gasoline storage and distributing plant at East Brooklyn, recently restroyed by fire with loss totaling $50,000, including equipment.

BALTIMORE—A complete laboratory will be installed in the new school of hygiene and public health to be erected at the Johns Hopkins University, estimated to cost about $1,000,000. Archer & Allen, Central Savings Bank Bldg., are architects.

Massachusetts

WORCESTER—The George C. Whitney Co., manufacturer of paper products, will break ground at once for the erection of a 6-story plant addition, 55x60 ft., near School St., to cost close to $50,000. Lockwood, Greene & Co., 24 Federal St., Boston, are architecs and engineers.

BROCKTON—The local plant of the Keith Oil Co. was partly destroyed by fire recently, with loss etsimated at about $12,000. It will be rebuilt.

BOSTON—The Hunt-Spiller Mfg. Co., 383 Dorchester Ave., manufacturer of iron castings, has work under way on a new 4-story plant addition, estimated to cost close to $30,000. The company recently took out a charter under state laws, with capital of 15,000 shares of stock, no par value. Wallace L. Gifford is president; and Robert F. Blake, 212 Beacon St., treasurer.

WOBURN — The Welch Japanning Co., Park St., will break ground at once for the erection of a new 2-story japanning works, 38x40 ft., at 38 Park St.

SOUTH HADLEY—The Holyoke Gummed Products Co., 9 Suffolk St., manufacturer of gummed paper products, will commence the immediate erection of a 1-story addition, 140x147 ft., estimated to cost about $40,000. Contract has been awarded to the Austin Co., 217 Broadway, New York. Maurice Moriarty is treasurer.

Michigan

PORT HURON—The New Egyptian Portland Cement Co., 1213 Ford Bldg., Detroit, has commenced work on the remodeling of the former local railroad shops, lately acquired, for a new cement-manufacturing plant. The work, with machinery installation, is estimated to cost in excess of $80,000. John A. Decker, 708 State St., Port Huron, is consulting engineer. John Gillespie is president.

ST. CLAIR—The Diamond Crystal Salt Co. has foundations in progress for a new 1-story plant addition, 50x150 ft., to be equipped as a machine shop and mechanical department. Henry Whiting is president.

Missouri

WEST PLAINS—The National Rendering Co., Kansas City, Mo., has plans under way for the construction of a new local plant for the manufacture of soaps and greases. Tankage and fertilizer will be secured from the works of the West Plains Serum Co., Lincoln Ave. W. R. Ross heads the company.

CONTINENTAL—The Alpha Portland Cement Co., Easton, Pa., is planning for the erection of an addition to the plant of the Continental Portland Cement Co., recently acquired for a consideration said to be $1,000,000. The new unit will cost approximately $500,000, with machinery. The local mill will be the ninth plant to be operated by the Alpha company, and will be increased in capacity from 3,200 to 4,500 bbl. per day.

New Jersey

EAST NEWARK—The John Hewitt Foundry Co. has tentative plans under consideration for the rebuilding of the portion of its plant on Sherman Ave., destroyed by fire recently with loss estimated at about $40,000.

BOUND BROOK—The Rubberoid Co., a subsidiary of the Standard Paint Co., manufacturer of composition roofing, roofing paints, etc., has completed plans for the erection of a 1-story building at its local works, 100x120 ft.

NEWARK—The Pittsburgh Plate Glass Co., 290 Elizabeth Ave., has work in progress on the first unit of its new linseed oil mill at Riverside and Chester Aves., adjoining its paint works at this location. The plant, with grain elevators and machinery, will cost approximately $300,000, and will give employment to about 100 men. It is expected to be ready for service early in March. Headquarters of the company are in the Frick Bldg., Pittsburgh, Pa.

TRENTON—The Jointless Fire Brick Co., 1130 Clay St., Chicago, Ill., has acquired a local site for the erection of a new fire brick and refractory plant, estimated to cost close to $75,000, with machinery. It will be equipped for an output of 2 carloads per day.

New York

GOUVERNEUR—The W. H. Loomis Talc Co., Main St., has plans nearing completion for the erection of a new 1-story plant on local site, 40x110 ft., estimated to cost approximately $50,000, with pulverizing and other machinery. W. H. Loomis is head.

OGDENSBURG—The Ogdensburg Paper Co. has tentative plans under consideration for the erection of a new 1-story mill addition to cost about $150,000, including equipment. George G. McKee is in charge.

North Carolina

ALBEMARLE—The City Council is taking bids until Jan. 11 for extensions and improvements in the municipal waterworks, including filtration plant, with chemical house and other departments. The Gilbert C. White Co., Durham, N. C., is engineer.

Ohio

NILES—The Ohio Galvanizing & Mfg. Co. is taking bids for the construction of a new 1-story plant addition, 72x120 ft., and will break ground at an early date. E. F. Bentley is head.

CINCINNATI — Fire, Dec. 17, destroyed two buildings at the plant of the Jarecki Chemical Co., at St. Bernard, near Cincinnati, with loss estimated at about $150,000, including equipment and stock. It is planned to rebuild.

ALLIANCE—Charles B. Smith and L. C. Cook of the Manufacturers' Sales Co., Alliance, have organized a new company to operate the pottery now in course of erection on site secured through the local Chamber of Commerce, between Sebring and Alliance. The initial structure will be 1-story 85x200 ft., and will be devoted to the decorating of whiteware and chinaware products. Two decorating kilns will be erected at the present time, and four additional such units at a later date. It is planned to commence operations late in January.

Oregon

SPRINGFIELD — The Carbolineum Wood Products Co., Portland, has arranged for the establishment of a new wood-treating and creosoting plant on local site. The present works at Alder will be removed to this location and additional equipment installed to provide a capacity of 1 carload per day.

Pennsylvania

POTTSTOWN — The Model Tire Co. has broken ground for the erection of a 1-story addition to its plant. George H. Starkweather heads the company.

AMBRIDGE—The Standard Seamless Tube Co., 313 6th Ave., Pittsburgh, manufacturer of steel tubing, is considering the erection of an addition to its local plant to cost about $75,000. H. E. Wharton is company engineer.

MIDLAND—The Pittsburgh Crucible Steel Co. has commenced the installation of a new liquid purification plant at its local works, to be equipped for a capacity of 12,000,000 cu.ft. It will be used to purify coke oven gases, and is expected to be ready for service early in March.

ALLENTOWN—The Royal Paper & Bag Co., 16 North 7th St., has authorized plans for the rebuilding of the 3-story plant, 60x230 ft., at 37-41 North 7th St., recently destroyed by fire.

Texas

HOUSTON—The Sinclair Refining Co. is said to have tentative plans under way for the erection of an addition to its oil refinery on the Houston ship channel for considerable increase in capacity.

PIONEER—The American Oil Co., Tulsa, Okla., has commenced the erection of the first unit of a new refining plant on local site, and will inaugurate work on the second unit at an early date. The total plant will have an output of about 5,000 bbl. per day, and is estimated to cost approximately $100,000. T. J. Ryans is president.

Virginia

GRAHAM—Sutphin & Snell are planning for the establishment of a local plant for the manufacture of shale brick, with daily output of about 50,000 bricks. Inquiries are being made for machinery and operating equipment.

GALAX—Work will be commenced at once on a new filtration plant at the municipal waterworks, to have a capacity of about 500,000 gal. gross. The Carolina Engineering Co., Wilmington, N. C., is engineer.

Washington

OLYMPIA—The West Coast Pulp & Paper Co., recently organized to construct and operate a local paper mill, will be operated by the same interests as control the Hawley Pulp & Paper Co., Oregon City, Ore. In addition to the acquisition of a local site for the proposed new mill, secured in co-operation with the Olympia Manufacturers' Association, the company has purchased a former brewery at Tumwater, and will remodel the structure for another paper mill. The larger mill to be constructed will cost close to $750,000 instead of $500,000, as previously announced, and is expected to be ready for service in about 12 months.

West Virginia

CHARLESTON — The Libbey-Owens Sheet Glass Co., Nicholas Bldg., Toledo, O., is completing plans for the erection of the proposed addition to its local plant, to include a number of new buildings, with machinery, estimated to cost approximately $2,000,000. The Owens Bottle Co., same address, a subsidiary organization, is also perfecting plans for the new addition to its Charleston works, comprising additional structures than those initially considered, increasing the estimated investment to about $750,000, with machinery. The Devore Co., Nicholas Bldg., Toledo, is engineer for both projects, and E. D. Libbey heads the companies.

CHARLESTON — The Evans Lead Co. is planning for immediate operations in the portion of its new local plant just completed, giving employment to about 100 workers. The plant will specialize in the production of red and white leads. Tentative plans are now under consideration for the erection of two additional factory units.

Mexico

SANTA EULALIA — The San Toy Mining Co. has tentative plans under way for extensions and improvements in its plant to cost about $400,000, including the installation of considerable new equipment. An appropriation of the amount noted has been arranged. Charles M. Schwab, head of the Bethlehem Steel Co., Bethlehem, Pa., is interested in the company.

Cuba

CAMAGUEY—The Estrella Sugar Central, Ltd., has plans under consideration for the rebuilding of the portion of its mill and power house at Cespedes, recently destroyed by fire, caused by an explosion.

Capital Increases, Etc.

THE ROESSLER & HASSLACHER CHEMICAL Co., 709 6th Ave., New York, has filed notice of increase in capital from $1,300,000 to $3,250,000.

THE FRENCHTOWN PORCELAIN CO., Frenchtown, N. J., manufacturer of electrical porcelain products, has arranged for an increase in capital from $100,000 to $350,000.

THE BOYDELL BROTHERS WHITE LEAD & COLOR Co., 432 East Lafayette St., Detroit, Mich., has filed notice of increase in capital from $150,000 to $337,500 for general expansion.

THE INDIANA ZINC CREOSOTING Co., Terre Haute, Ind., has arranged for a change of name to the Indiana Wood Preserving Co.

THE UNION CARD & PAPER Co., 45 Beekman St., New York, N. Y., has arranged for an increase in capital from $150,000 to $500,000.

THE PERTH AMBOY CHEMICAL WORKS, INC., 71 Buckingham St., Perth Amboy, N. J., has filed notice of increase in capital from $40,000 to $1,000,000 for proposed expansion.

Industrial Developments

PAPER—All of the paper mills at Windsor Locks, Conn., have adopted a capacity schedule, covering day and night forces on an 8-hr. shift. The plants include the American Writing Paper Co., C. H. Dexter & Sons, and the Windsor Locks Paper Mills, Inc., the last noted being operated by J. L. Smyth Co., New York.

Paper and pulp mills at Fort William, Ont., have increased operations and are now running on a heavier production schedule than for a number of months past.

The Spruce Falls Co., Kapuskasing, Ont., has completed the construction of a local sulphite pulp mill and will operate at the plant at maximum capacity for an indefinite period.

CERAMIC—A complete settlement has been effected in the general ware branch of the pottery industry, following a 10 weeks' strike, with a compromise wage advance of 4½ per cent over previous schedules. The men asked for a 7 per cent increase.

The Creighton Brick & Tile Co., Creighton, Mo., is perfecting plans for the early resumption of production at its local plant, following a shut-down for a number of months.

The Independent Brick Co., Trenton, N. J., is maintaining active operations at three of its four brick manufacturing plants at Bordentown and vicinity, and expects to continue on this basis throughout the winter season.

The Kenyon Brick & Tile Co., Oklahoma City, Okla., is continuing production on a capacity schedule, and purposes to make a number of plant additions to develop a maximum of 40,000 bricks per day, as well as building tile and other burned clay products.

General ware potteries at Trenton, N. J., are advancing production, following the settlement of the strike with the operative potters. Philadelphia, Pa., potteries are also increasing their outputs, and the majority of plants in this district are now running close to 100 per cent.

The Perth Amboy Tile Co., Perth Amboy, N. J., is maintaining full capacity at its local works and has extensions under way for early increase.

The Birmingham Hollow Tile Co., Ensley, Ala., is running full, with regular working force. Orders on hand are said to insure continuance on this basis thfoughout the winter season.

The Standard Brick Mfg. Co., Evansville, Ind., is running at both of its plant at normal capacity, and plans to continue at least one of the factories in service during the winter months.

RUBBER—The General Tire & Rubber Co., East Akron, O., is completing the erection of three new plant additions at its local works, and proposes to place the units in full service in January or February. The present output is on a basis of 2,500 tires daily, and this production will be doubled as soon as the new units are ready.

The Kelly-Springfield Tire Co., Akron, O., is maintaining production on a capacity schedule and will continue on this basis for an indefinite period.

METALS—Following the closing of a contract with the American Smelting & Refining Co. for the purchase of its entire output of zinc concentrate for a period of 5 years, the Callahan Zinc & Lead Co., Cœur d'Alene, Idaho, is arranging to increase production at its local plant. The Callahan company has acquired a substantial interest in the Galena Mining Co., operating in this same district, and proposes to advance the output at the works.

The Bay View Foundry Co., Sandusky, O., is arranging for the reopening of its plant early in January, after a shut-down for more than 24 months.

The International Nickel Co. has advanced production at its Port Colborne, Ont., plant to the highest point since the close of the war, giving employment to a large increased working force. For the first time in 4 years, the entire production of Monel metal is being shipped from the plant.

The brass foundry of the New Holland Machine & Foundry Co., New Holland, Pa., has increased production to a full time basis, giving employment to the regular working force, for the first time in a number of weeks past.

The Mohawk Mining Co., Calumet, Mich., is running two heads at its stamp mill, under a 3-shift working day, on a production schedule of handling 36,000 tons of rock per month.

IRON AND STEEL—The Woodward Iron Co., Woodward, Ala., is arranging to blow in its No. 1 furnace early in January. The unit was closed down recently for necessary repairs.

The National Tube Co., Pittsburgh, Pa., a subsidiary of the United States Steel Corp., is advancing operations at its Riverside works, Wheeling, W. Va., a plant that is used for reserve service in times of heavy demand. Both blast furnaces have been blown in, while two bessemer converters are operating; five of seven welding furnaces will also be active for an indefinite period.

The Minnesota Steel Co., Duluth, Minn., is running on a capacity basis and will continue on this schedule for an indefinite period.

The Trumbull Steel Co., Youngstown, O., is developing increased production, and record shipments are being made from the mills. A new high average was attained in November, with a moved finished tonnage of 32,000 tons of sheets, strip steel and tin plate. A full working force is being employed.

The Carnegie Steel Co., Pittsburgh, Pa., has blown in several additional furnaces during December, and will soon have 45 or 46 stacks in blast.

In the district bounded by Johnstown, Pa., Wheeling, W. Va., and Warren, O., a total of 99 blast furnaces out of 139 stacks are now in operation, the largest number in more than 2 years.

The Republic Iron & Steel Co., Birmingham, Ala., has two furnaces in blast at its local works, and will keep the stacks active for an indefinite period. The Central Coal & Iron Co., in this same district has one stack in service, as has also the Alabama Co.

MISCELLANEOUS — The Oak Extract Co., Newport, Pa., manufacturer of sulphuric, nitric and other acids, has resumed operations at its plant, following a curtailment for several months due to difficulty in securing raw materials.

The Taylor Brothers Co., Rockdale, Tex., has completed the installation of equipment for an increase from 75 to 100 bbl. per day at its oil-topping plant and has placed the unit in service on a full production basis.

Cotton oil mills at Charlotte, N. C., and vicinity have increased production to full-time basis operations, and will maintain this schedule until early in February.

The Corn Products Refining Co. is giving employment to a total of 650 persons at the ne wmill at North Kansas City, Mo., on a full-time operating basis.

New Companies

THE HEDGES & DIVINE ZINC CO., 3039 East 92nd St., Chicago, Ill., has been incorporated with a capital of $30,000, to manufacture zinc and other metal products. The incorporators are M. J. J. Rieck, C. W. Kraft and F. A. Thulin.

THE HUDSON ALCOHOL CO., West New York, N. J., has been incorporated with a capital of $10,000, to manufacture denatured alcohol and kindred products. The incorporators are Nicholas and Dominick Curcio, 761 Bergenline Ave., West New York. The last noted represents the company.

THE GREENWICH CHEMICAL CO., New York, N. Y., care of S. V. Ryan, attorney, Albany, N. Y., representative, has been incorporated with a capital of $200,000, to manufacture disinfectants, insecticides and other chemical products. The incorporators are S. C. Wood and H. C. Hand.

THE ALBERT H. BECK CO., Philadelphia, Pa., has been incorporated with a capital of $50,000, to manufacture glass products. R. M. Beck, 3935 North 7th St., Philadelphia, is treasurer and representative.

THE RAYNAUD-CONRAD PAINT CO., New Orleans, La., has been incorporated with a capital of $100,000, to manufacture paints, varnishes, oils, etc. The incorporators are Joseph Raynaud, C. Carlisle Conrad and George Steele, all of New Orleans.

THE WILLIMANTIC RIVER PAPER CO., care of the Colonial Charter Co., Ford Bldg., Wilmington, Del., has been incorporated under Delaware laws with capital of $325,000, to manufacture paper products, with mill in New England.

THE CHARLES WALSH CO., Philadelphia, Pa., has been incorporated with a capital of $50,000, to manufacture brick, tile and kindred products. F. E. White, 6132 Lebanon Ave., Philadelphia, is treasurer and representative.

THE KEENE CHEMICAL CO., New York, N. Y., care of S. S. Winter, 261 Broadway, New York, representative, has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. The incorporators are S. M. Morecy, J. Weissbaum and E. H. Barker.

THE SOUTHERN ATLANTIC FERTILIZER CO., Augusta, Ga., has been incorporated with a capital of $15,000, to manufacture fertilizer products. The incorporators are R. C. Neely, Sr. and Jr., and S. H. Wilcox, all of Augusta.

THE ANT-ROACH POWDER CO., Newark, N. J., has been incorporated with a nominal capital of $5,000, to manufacture insect powders and other chemical specialties. The incorporators are Edward H. Zimmerman, George C. Weber and John A. Berringer, 83 South Orange Ave., Newark. The last noted represents the company.

THE RAYDNT CORP., Pittsburgh, Pa., care of the Capital Trust Co. of Delaware, Dover, Del., representative, has been incorporated under Delaware laws with capital of $25,000, to manufacture varnishes, polishes, etc.

THE AMAREX CORP., New York, N. Y., care of Holmes, Rogers & Carpenter, 20 Broad St., New York, representatives, has been incorporated with a capital of $20,000, to manufacture chemical products. The incorporators are F. Ferranti and O. Rodinella.

THE PITTSBURGH OIL & REFINING CO., Pittsburgh, Pa., is being organized to manufacture refined oils. The incorporators are Robert A. Rundle, George Faunce, Jr., and Clyde D. Beistel. Application for a state charter will be made on Jan. 8. The company is represented by J. Merrill Wright and Robert A. Rundle, 624 Frick Bldg., Pittsburgh.

THE L. J. TILLERY OIL CO., Beaumont, Tex., has been incorporated with a capital of $85,000, to manufacture petroleum products. The incorporators are L. J. Tillery, J. D. Campbell and C. G. Hooks, all of Beaumont.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its annual meeting in Pittsburgh, Pa., Feb. 12 to 17, 1923.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting April 3 to 7, 1923, at New Haven, Conn.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting May 3, 4 and 5, 1923, at the Commodore Hotel, New York City.

AMERICAN ENGINEERING COUNCIL, executive organ of the Federated American Engineering Societies, will meet in Washington, D. C., Jan. 11 and 12, 1923.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its annual meeting in New York City during the week of Feb. 19, 1923.

AMERICAN SOCIETY FOR STEEL TREATING will hold its winter sectional meeting in the City Club, Chicago, Feb. 15 and 16, 1923.

INTERNATIONAL CHAMBER OF COMMERCE will hold its second general meeting in Rome, Italy, March 19-26, 1923.

NATIONAL FOREIGN TRADE COUNCIL will hold its annual conference April 25, 26 and 27, 1923, in New Orleans, La.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS, with headquarters in Chicago, will hold its spring convention in Cincinnati, April 18, 19 and 20, 1923. The major subject will be "Management Problems of the Smaller Plants."

A PAPER INDUSTRIES EXPOSITION will be held in Grand Central Palace, New York City, during the week of April 9, 1923, by the International Exposition Co.

The following meetings are scheduled to be held in Rumford Hall, Chemists' Club, East 41st St., New York City: Jan. 5 — American Chemical Society, regular meeting. Jan. 12—Society of Chemical Industry, Perkin Medal. Feb. 9—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting. March 9—American Chemical Society, Nichols Medal. March 23—Society of Chemical Industry, regular meeting. April 20—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting. May 4—American Chemical Society, regular meeting. May 11—Société de Chimie Industrielle (in charge), American Chemical Society, American Electrochemical Society, Society of Chemical Industry, joint meeting. May 18—Society of Chemical Industry, regular meeting. June 8—American Chemical Society, regular meeting.